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COMMONWEALTH OF PENNSYLVANIA

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REPORT ON
THE SANITARY SURVEY
OF THE
ALLEGHENY RIVER BASIN

BY THE
DEPARTMENT OF HEALTH
OF THE
COMMONWEALTH OF PENNSYLVANIA



HARRISBURG, PA.
WM. STANLEY RAY, STATE PRINTER
1915.

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CRAWFORD COUNTY:Cambridge Springs Bor.,	Municipal Waterworks.
VENANGO COUNTY:Franklin City,	Municipal Waterworks.
ELK COUNTY:	.....Ridgway Borough,	Municipal Waterworks.
JEFFERSON COUNTY:	.....Punxsutawney Borough, Punxsutawney Water Co.	
	.....Brookville Borough,	Municipal Waterworks.
CLARION COUNTY:	.....Clarion Borough,	Clarion Water Co.
ARMSTRONG COUNTY:	....Parker City,	Parker City Water Co.
	.....Freeport Borough,	Freeport Waterworks Co.
	.....Kittanning Borough,	Armstrong Water Co.
	.....New Behlechem Borough,	Citizens Water Co.
	.....Apollo Borough,	Apollo Waterworks Co.
INDIANA COUNTY:	.....Indiana Borough,	Clymer Water Co.
	.....Ernest Village,	Jefferson and Clearfield Coal and Iron Co.
	.....Iselin Village,	Pittsburgh Gas Coal Co.
WESTMORELAND COUNTY:	New Kensington Bor- ough,	Kensington Water Co.
	.....Vandergrift Borough, ...	Vandergrift Water Co.
ALLEGHENY COUNTY:	....Natrona Village,	Natrona Water Co.
	.....Brackenridge Borough, ..	Allegheny Valley Water Co.
Pittsburgh Suburbs,	Pennsylvania Water Co.
Pittsburgh,	Municipal Waterworks.

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LIST OF SEWAGE TREATMENT PLANTS AND THEIR OWNERSHIP, IN THE ALLEGHENY RIVER BASIN, 1912.

NEW YORK STATE:

Olean City,	Tannery Company.
Cuba Village,	Municipality.
North Olean Village,	Municipality (2).
Bolivar Village,	Municipality.
Chautauqua,	Association.

PENNSYLVANIA:

Norwich Village,	McKean County,	Lumber Company.
Bells Camp,	McKean County,	Tuberculosis League
Glade Village,	Warren County,	Tannery Company.
Stoneham Village,	Warren County,	Tannery Company.
Warren State Hospital,	Warren County,	State Hospital.
Warren Borough,	Warren County,	Water Company.
Corry City,	Erie County,	Tannery Company.
Spring Creek Village,	Warren County,	Tannery Company.
Pleasantville Borough,	Venango County,	Municipality.
Polk Borough,	Venango County,	State Institution.
Indiana Borough,	Indiana County,	Municipality.
Derry Borough,	Westmoreland County, ..	Municipality.
Claremont,	Allegheny County,	
Allegheny City Home,		Municipality.
Allegheny County Workhouse,		County.
Aspinwall,	Allegheny County,	Municipality.
Springdale Borough,	Allegheny County,	Glue Company.

The Department of Health of the Commonwealth of Pennsylvania was placed in charge of the health of the people and the purity of the waters of the Commonwealth under Acts of Assembly respectively entitled:

"An Act creating a Department of Health, and defining its powers and duties," approved the 27th day of April, A. D., 1905, P. L. No. 218, page 312, and

"An Act to preserve the purity of the waters of the State, for the protection of the public health," approved the 22nd day of April, A. D., 1905, P. L. No. 182, page 260.

In organizing the Department a Division of Sanitary Engineering was established and immediate inspection was started in thirty districts to take out the sewage pouring into the streams from private sources, and the municipalities with their old combined systems had to be carefully studied before comprehensive sanitary systems could be decided upon and finished by the individual cities and boroughs.

While the work was carried on throughout the Commonwealth the public water supplies were studied. This work in the majority of municipal water supplies involved the small watersheds throughout the 45,000 square miles of territory in the State. This, however, gave us valuable data on the sources that went to make up our large streams.

The Department of Health of the Commonwealth of Pennsylvania from the time of its creation has consistently endeavored to protect and purify the water supply in order to enable the citizens of the State to procure water that is safe as well as palatable. To this end the watersheds of particular supplies have been inspected and re-inspected as occasion arose. In addition to this more extensive surveys have been undertaken to acquire precise information concerning the condition of the larger streams. This information is as yet somewhat fragmentary except for the basin of the Allegheny River.

The Allegheny River Basin loomed up in importance on account of its topography, the large population, and numerous industries that were discharging wastes into the River. With a full realization of the necessity of having a more precise knowledge of the existing conditions so as to enable us to decide what procedure would best protect this water and inaugurate metropolitan sewerage systems a careful compilation of the work has been correlated with special

comprehensive studies. This work was done under the direction of the Department and the supervision of the Chief Engineer, F. Herbert Snow.

The fundamental inspections were made in 1909 and 1910, and these were supplemented by numerous later examinations, so that our notes present the conditions substantially as they existed at the end of the year 1912.

The material thus collected has been partially available to our engineers in the form of notes, but these were not in shape for publication. Requests for information concerning the basin of the Allegheny River have come from time to time from various official boards directly interested in the sanitary condition of this great River, as the Pittsburgh Typhoid Fever Commission, the Corps of Engineers, of the United States Army, and the United States Public Health Service. Similar requests have been made by certain eminent sanitary engineers. Hitherto these memoranda were not yet sufficiently elaborated to permit of general use. In view, however, of the considerable and growing interest in the matter it has been decided to put the material on hand in proper form for printing that it may be readily accessible to all.

SAMUEL G. DIXON.

Harrisburg, July 1914.

SANITARY SURVEY OF THE ALLEGHENY RIVER WATERSHED

INTRODUCTION.

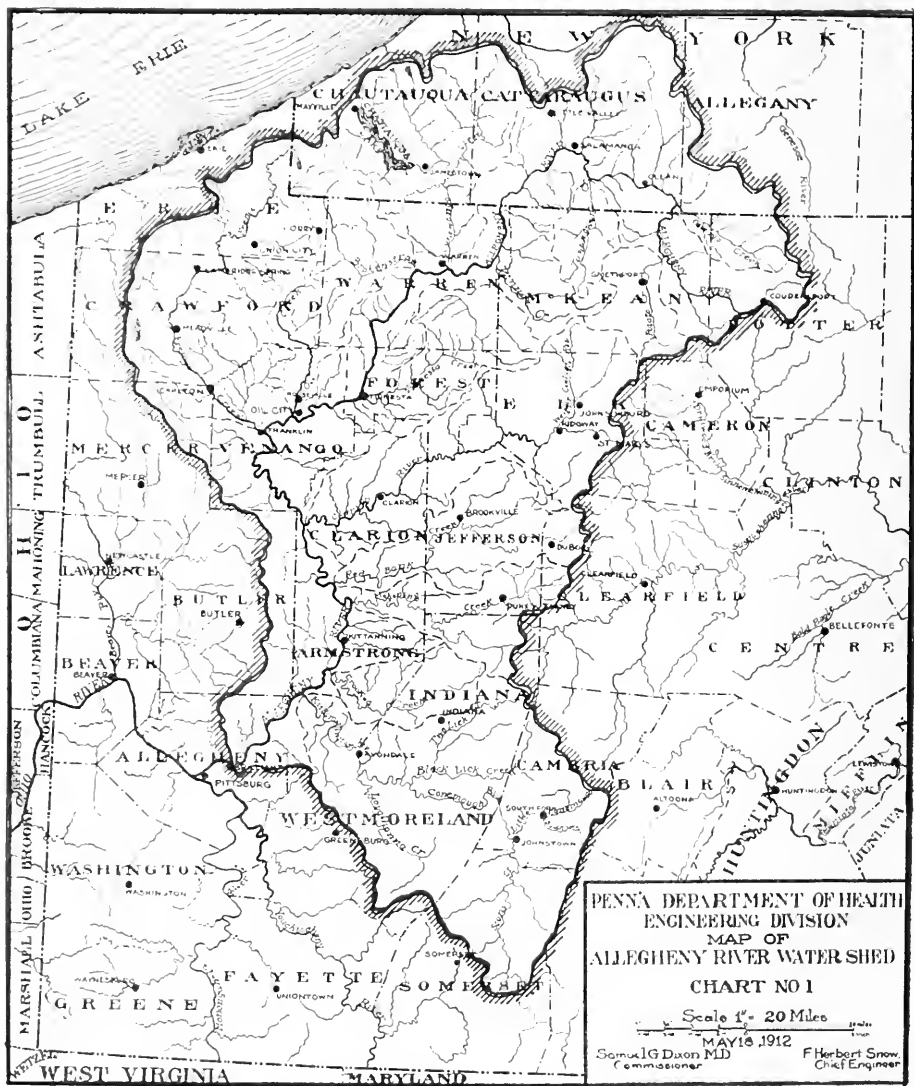
In carrying out the provisions of law under which the State Department of Health is conserving the purity of the waters of the State for the protection of public health, it has been found inadvisable to establish a uniform policy respecting details for all watersheds. Each considerable stream may present a separate and different problem. The uses to which the waters are or may be put, the physical characteristics of the stream and its watershed, the density of population and the extent and causes of pollution are among the many points to be carefully considered in determining what policy will best promote and conserve public health. The survey described in this report was undertaken to ascertain as nearly as practicable the essential facts required to work out a policy for the Allegheny Basin and its tributary streams.

Under the direction of the Chief Engineer, Mr. F. Herbert Snow, a sanitary survey was made of the Allegheny River basin by Assistant Engineer, Mr. Paul Hooker, and numerous other officers of the Engineering Division. Mr. Hooker prepared a report which has formed the basis for this report and from which much has been copied. The work included a study of the reports on investigations of conditions in a large number of public and private corporations, such as cities, boroughs and water companies, made in the course of the routine work of the Department, a special field investigation of municipalities not so covered, and a general field survey of the entire watershed.

It seemed best to confine the investigation to the portion tributary to the river above Brilliant, eight miles from the mouth. There were various reasons leading to the omission of the lower portion of the river, chief among them being that the condition of the stream below this point is inseparably connected with the sanitary problem of Greater Pittsburgh, which is the subject of an independent study now being conducted.

A detailed description is given of the river and its principal affluents with discharge measurements and pertinent analyses. Considerable attention has been paid to the resources of the region as bearing on the value of the river as a sewage and waste channel compared with its importance as a source of public water supply. The latter part of the report is devoted to population and pollution, with especial attention to the principal polluting agencies, the occurrence of typhoid fever, and the relation of the study to the water supply of Pittsburgh.

In the compilation, recourse was had to many records and reports, both published and in manuscript form and the information therein has been freely used. The Water Supply Commission of Pennsylvania has placed records of stream measurements and other data at the disposal of the Department of Health. The State Department of Mines has supplied information requested, and the New York State Department of Health contributed a report on conditions on the watershed within that State. Frequent recourse has been had to the Report of the Pittsburgh Flood Commission.



PART I

GENERAL DESCRIPTION OF ALLEGHENY RIVER BASIN.

The Allegheny River is the principal tributary of the Ohio, whose source is the confluence of the Allegheny and the Monongahela. The name Allegheny is derived from a word of the Seneca Indian dialect, meaning "Fair Water," and as Ohio in other Indian dialects has the same meaning it is inferred that the aborigines regarded the Allegheny and the Ohio as one stream.

Its drainage area, known as the Allegheny Basin, lies in the northern part of the Allegheny plateau region and comprises the greater part of the western slope of the Allegheny Mountains in Pennsylvania, embracing over one-fifth of the area of the State, and a part of the western end of New York. The total area of the Allegheny Basin is 11,400 square miles, of which 9,310 square miles lie within the borders of Pennsylvania. It is about 124 miles in extreme width and 175 miles in length, extending from the central part of Potter county on the east to its western limit in Crawford county, about ten miles from the Ohio State line. Its northern limit lies about thirty miles north of the New York-Pennsylvania State line and to the south it extends to within twelve miles of the southern border of the State in Somerset county.

In the northwest the dividing line approaches Lake Erie extending to within five miles of the Lake in Erie County, Pennsylvania, and to within three miles in New York State. "The Continental Divide" forms the eastern margin of this great basin extending to an elevation of about 2,800 feet. The northern divide in New York State reaches to about 1,775 feet. About eighty-five miles from its mouth the river approaches to within six miles of the western divide, which at this point attains an elevation of about 1,550 feet—approximately 700 feet above the river level.

The territory drained by the Allegheny River embraces regions of widely varying topographical character, ranging from the high rounded hills characteristic of Potter and McKean counties to broad terraced valleys with wide bottom lands in New York State; from the steep hills and broken country of the eastern slope to the comparatively level, marshy, lacustrine, western slope.

In preglacial times all the drainage of this basin flowed to the northwest into the Lake Erie Basin and thence to the St. Lawrence. Three distinct streams then existed corresponding closely, within the

limits of the basin, to the upper, middle, and lower portions of the Allegheny river. During the Kansan glacial stage the ice cap extended into the northern and western portions of what is known as the Allegheny Basin, forming a barrier which cut off the three outlets and completely changed the drainage system. It was then that the Allegheny river took its present position following the terminal moraine for about 200 miles from its source to the centre of Venango county. The deep valleys and the steep ridges characteristic of the eastern slope clearly point to great age. On the other hand, the northwestern slope is marshy, with frequent lakes and ponds overlying deep deposits of glacial drift, indicating recent formation.

The stratification exposed comprises portions of the Devonian and Carboniferous series, chiefly the latter, the oldest formations appearing to the north. The general dip is slight and to the southwest. Surface indications begin with the Chemung passing through the Catskill (both of the Devonian Systems) then through the Mississippian (Lower Carboniferous) series, and Pennsylvanian (Upper Carboniferous) series of the Carboniferous System. The Pennsylvanian or Upper Carboniferous coal measures comprise the Appalachian Coal Field, underlying the greater part of the Allegheny Basin.

The Allegheny River which drains the great basin described above rises in the high, hilly plateau region of the northeastern part of the basin at an elevation of 2,250 feet above sea level. Here, in an area of less than one square mile near the centre of Potter County, rivulets find their origin, leading eventually to the waters of the Gulf of St. Lawrence, by way of the Genesee River, to Chesapeake Bay, by way of the Susquehanna River, and to the Gulf of Mexico, by way of the Allegheny. From its source the Allegheny flows in a general northwesterly direction about eighty miles, crossing into New York State, to a point eleven miles north of the State line. Here it turns abruptly to the southwest, continuing in this direction one hundred and twenty miles to the central part of Venango County, after running in all about forty-seven miles through New York. It then turns to the southeast and again to the southwest one hundred and ten miles to its confluence with the Monongahela to form the Ohio River, the total length of the Allegheny being about three hundred and ten miles. Its channel is generally broad and shallow averaging 300 feet in width throughout its course in New York State and for the lower one hundred and forty miles of its course from 480 feet to 2,140 feet in width.

In the upper part the bottom consists of fine sand and gravel for about one hundred and fifteen miles from the source. Its character then changes; loose stones and boulders appear and gradually increase in number until the bottom in the lower portion of the river consists largely of broken irregular masses of loose rock. Solid rock seldom appears in the river bed.

The course of the stream throughout is a series of pools and ripples, the pools gradually deepening toward the mouth to sixteen feet or more. The waters are naturally clear. During the low water period in 1897 the bottom was visible at a depth of sixteen feet in some of the pools.

Section 1.—Areas of Main Tributaries.

A great many streams, some of them quite large, unite to form the Allegheny River. In Table I its main tributaries, with the drainage area of each, are given in consecutive order, beginning at the headwaters.

TABLE I.—Main Tributaries of the Allegheny River.

Stream.	Drainage Area Square Miles.	Distance above Mouth in Miles
Potato Creek,	240	272
Oswayo Creek,	218	261
Tunungawant Creek,	164	240
Conewango Creek,	535	192
Brokenstraw Creek,	300	184
Tionesta Creek,	458	154
Oil Creek,	285	134
French Creek,	1,180	16
Clarion River,	1,175	85
Red Bank Creek,	526	79
Mahoning Creek,	397	58
Crooked Creek,	280	41
Kiskiminetas River,	1,846	30

Section 2.—Distribution of Rainfall.

The mean annual precipitation over the entire Allegheny River watershed is 42.35 inches. Table II shows the rainfall at various points within this area. The figures are taken from records of readings made by the United States Weather Bureau or its local observers, and published in its bulletins. The Water Supply Commission furnished the compilation.

TABLE II.—Rainfall.

Station.	County.	Sub-Basin.	Elevation above sea level in feet.	Annual Precipitation in Inches.			
				Record complete.	Total period.	Maximum.	Minimum.
Arsenal,	Allegheny,	Allegheny River,	794	29	36	52.02	25.62
Brookville,	Jefferson,	Red Bank Creek,	1,235	29	22	55.48	40.97
Cassandra,	Cassandra,	Conemaugh River,	2,100	12	13	48.24	38.06
Carlton,	Carlton,	Allegheny River,	1,330	9	14	58.56	38.41
Corry,	Allegheny,	Allegheny River,	1,110	7	8	65.66	36.43
Derry Station,	Westmoreland,	Kiskiminetas River,	1,112	7	11	51.19	39.10
DuBois,	Clearfield,	Red Bank Creek,	1,329	6	7	48.29	42.33
Franklin,	Venango,	French Creek River,	1,855	29	36	57.63	31.70
Freeport,	Armstrong,	Kiskiminetas River,	772	27	39	57.63	31.70
Harris Island Dam,	Allegheny,	Allegheny River,	710	8	9	35.48	31.70
Hawthorne,	Carlton,	Red Bank Creek,	1,073	6	6	49.71	37.93
Johnstown,	Cambla,	Kiskiminetas River,	1,134	23	26	57.39	37.55
Ligonier,	Westmoreland,	Kiskiminetas River,	1,750	5	5	71.22	50.29
Lyceus,	Westmoreland,	Kiskiminetas River,	1,420	16	17	51.38	44.61
Mahoning,	Armstrong,	Mahoning Creek,	819	9	12	58.84	35.83
Meadville,	Crawford,	French Creek,	1,078	2	2	50.62	43.23
Mill City,	Venango,	Oil Creek,	1,045	23	26	50.62	43.04
Parkers Landing,	Armstrong,	Carlton River,	888	21	22	57.29	32.52
Ridgway,	Elk,	Carlton River,	1,390	8	9	44.71	39.92
Saltburg,	Indiana,	French Creek,	1,116	15	15	52.29	31.97
Shingle House,	Allegheny,	Kiskiminetas River,	891	11	18	53.28	38.35
Smithport,	McKean,	Oswayo Creek,	1,475	4	8	48.29	37.37
Springdale,	Allegheny,	Potato Creek,	1,500	7	21	47.35	30.65
Storetown,	Somerset,	Kiskiminetas River,	152	1	2	42.71	41.98
Tarentum,	Allegheny,	Kiskiminetas River,	906	4	5	47.91	41.84
Warren,	Warren,	Allegheny River,	1,137	2	9	40.90	37.50
Worthington,	Armstrong,	Conemaugh Creek,	1,050	21	24	53.22	32.54
Average,		Allegheny River,		4	4	53.22	49.45
							42.35

Section 3.—Slopes.

The surface slope is very steep near the head waters, changing abruptly to a flat grade in New York State. On re-entering Pennsylvania, the slope again becomes steep, gradually diminishing toward the mouth. Table III gives the slope in feet to the mile in consecutive sections of varying length covering the entire course of the river.

TABLE III.—Slopes of the Allegheny River Channel.

Miles from Source.	Slope— Feet per Mile.	Approximate Velocity Miles per Hour.
0 to 30,	27.0	7.77
30 to 55,	2.0	2.15
55 to 75,	1.7	1.94
75 to 95,	2.7	2.87
95 to 115,	5.0	3.26
115 to 125,	2.5	2.79
125 to 150,	3.5	2.79
150 to 182,	3.0	2.58
182 to 308,	2.1	2.18

In the computations to obtain the approximate velocity per hour, in the formula, $V=c\sqrt{rs}$: V =ft. per sec.; $c=75$ ($\frac{+}{-}$); $r=4.5$ ($\frac{+}{-}$); s =slope (ratio).

These velocities are for the normal stage of the river. The maximum velocities are much in excess of those appearing in the above table.

Section 4.—Distances.

Table IV shows the distance along the Allegheny from its mouth and from its approximate source to the various bridges, larger towns and the mouths of the principal tributaries.

It is compiled mainly from the reports of the surveys of the river made by the United States Army Engineers in 1897 and prior to that date.

TABLE IV.—Distance Along Allegheny River.

Distance in Miles.		Place.
From Mouth.	From Source.	
0.0	308.0	Union Bridge, at the Point, Pittsburgh.
0.5	307.5	Sixth Street Bridge.
0.6	307.4	Seventh Street Bridge.
0.7	307.3	Ninth Street Bridge.
1.0	307.0	Fort Wayne R. R. Bridge.
1.3	306.7	Sixteenth Street Bridge.
1.7	306.3	Herr Island Lock (Twenty-first Street).
2.3	305.7	Thirtieth Street Bridge.
2.4	305.4	Pittsburgh Junction R. R. Bridge.
3.4	304.6	Forty-third Street Bridge (Millvale).
5.3	302.7	Butler Street Bridge (Sharpsburg and Etma).
7.0	301.0	Six-mile Island Lock (No. 2) and wing dam.
7.3	300.7	Aspinwall.
8.3	299.7	Shades Run (Pittsburgh City line).
11.2	296.8	Verona.
14.0	294.0	Pittsburgh, Buffalo & Lake Erie R. R. Bridge.
16.4	291.6	Lock No. 3 Springdale).
19.3	288.7	New Kensington.
21.6	286.4	Tarentum (Bull Creek).
24.2	283.8	Natrona.
25.7	279.3	Freeport Bridge.
30.0	275.0	West Pennsylvania Railroad Bridge.
30.2	274.8	Kiskiminetus River.
32.7	272.3	Clinton.
36.2	271.8	Kelly.
37.8	270.2	Nicholsons Dam.
38.2	269.8	Logansport.
40.7	267.3	Rosston.
42.0	266.0	Ford City.
43.7	264.3	Manorville.
45.6	262.4	Kittanning Bridge.
48.7	259.3	Lower Cowanshannock Dike.
49.1	258.9	Upper Cowanshannock Dike.
51.2	256.8	Mosgrove.
55.5	252.5	Templeton.
56.2	251.8	Mahoning.
61.0	247.0	Rhinerton.
62.1	245.9	Riverview.
64.5	243.5	Red Bank Dike.
64.9	243.1	Red Bank Creek.
65.0	243.0	Red Bank Junction.
67.6	240.4	Phillipston.
70.7	237.3	East Brady.
73.5	234.5	Catfish Run.
76.4	231.6	Lower Hillsville.
80.5	227.5	Monterey.
87.0	223.0	Parker Bridge.
86.1	221.9	Clarion River.
87.8	220.2	Foxburg Bridge.
91.6	216.4	Emlenton Bridge.
94.7	213.3	Potter.
101.4	206.6	Rockland.
104.3	203.7	St. George.
110.0	198.0	Kennerdell.
115.9	192.1	Brandon.
120.9	187.1	East Sandy.
125.1	182.9	Blue Rock Bridge.
126.4	181.6	Franklin Bridge.
130.7	177.3	Reno.
131.0	174.0	Oil City Suspension Bridge.
131.1	173.9	Oil City Relief Bridge.
131.2	173.8	Oil City and Petroleum Bridge.
134.7	172.4	Allegheny Valley Railway Bridge.
135.6	172.4	Horse Creek.
141.1	166.9	Walnut Bend.
142.7	165.3	Oleopolis.
143.5	164.5	Pithole Creek.
145.3	162.7	Henry's Run.
146.9	161.1	Hemlock Creek.
149.1	158.9	Baums Station.
150.5	157.5	Hunters Run.
152.3	155.7	Little Tionesta Creek.
154.4	153.6	Tionesta Bridge.
157.2	150.8	Dales Island Head.
159.6	148.4	West Hickory Creek.
161.4	146.6	East Hickory Creek.
162.8	145.2	Hemlock Island Head.
166.7	141.3	Porterfield Island Head.
169.2	138.8	Fidloute.
170.9	137.1	Coursin Island Head.
173.2	134.8	Mazoes Run.
176.2	131.8	Conklin Run.
177.2	130.3	Thompson's Run.
179.4	128.6	Clarks Island Head.
180.1	127.9	Dunn's Island Foot.

Distance in Miles.		Place.
From Mouth.	From Source.	
182.3	125.7	Brokenstraw Island Foot.
184.0	124.0	Brokenstraw Creek.
186.9	121.1	Jackson's Run.
188.4	119.6	Mead's Island Head.
191.5	116.5	Warren Suspension Bridge.
191.5	116.1	Conewango Creek.
192.9	114.1	Morrison's Creek.
196.0	112.0	Shipman's Island Head.
196.9	111.1	Hooks Island Mill.
199.1	108.9	Long or Goose Island, Foot.
200.9	107.1	Bents Run.
202.2	105.8	Kinzua Creek.
202.7	105.3	Licks Run.
204.2	103.8	Kinzua Island, Head.
205.5	102.5	Sugar Creek.
206.0	102.0	Hodges Run.
207.2	100.8	Lower Cornplanter Island No. 2, Foot.
208.4	99.6	Lower Cornplanter Island No. 1, Head.
208.9	99.1	Cornplanters Creek Monument.
210.4	97.6	Tracey Run.
211.2	96.8	Brown's Island Head.
212.4	95.6	Corydon.
213.7	94.3	New York & Pennsylvania State Line.
235.0	73.0	Salamanca, N. Y.
253.0	55.0	Olean, N. Y.
261.0	47.0	State Line.
308.0	0.0	Source.

Steep slopes favor water power development. Flat slopes favor sedimentation. It will be seen in Table III that the least velocity is 1.94 miles an hour. Running water in a stream whose velocity is sufficient and whose section is favorable for the movement of sediment, has a tremendous power for transportation. One would conclude, therefore, that the Allegheny River would bring along its course large quantities of sediment. This is true, as will appear later, and with it come the pollutions contributed by the inhabitants and the industrial plants in the basin.

PART II

STREAM FLOW.

Section 1.—Floods and Control.

The flow of the Allegheny River is quite erratic on account of the varied character of the watershed. The streams entering from the east are subject to sudden changes in volume, while those of the west maintain a comparatively steady flow. The river is peculiarly subject to ice gorges, owing to the cold winters in the region about its head waters, and to its rapid current, short bends and sudden freshets—thirty inches of ice being not unusual on the upper river. High water stages are most frequently reached from January to April; low water usually during months of September and October. There have been fifty-three floods in Pittsburgh during the last forty years. The maximum flood occurred in 1907. Millions of dollars worth of property are annually sacrificed along the Allegheny and Ohio Rivers due to the overflowing of their banks. The flood damage at Pittsburgh is so extensive as to call for relief. The Flood Commission of the city of Pittsburgh, after an exhaustive study, has proposed the building of storage reservoirs to hold back the flood water and the construction of protective walls along the banks through the city. Thirteen dams are proposed.

The site of dam No. 1 is on the Allegheny River four miles above Oil City. The dam is to be sixty-three feet high, flood back sixteen miles, and have a storage capacity of 2.9 billion cubic feet. The site of dam No. 2 is just above No. 1. reservoir. The dam is to be sixty-six feet high, flood back sixteen miles and have a storage capacity of 4.9 billion cubic feet. The site of dam No. 3 is on the river just above No. 2 reservoir. This dam is to be fifty-four feet high, flooding back fifteen miles and having a storage capacity of 2.7 billion cubic feet.

The site of dam No. 4 is on Tionesta Creek one mile above the mouth. The dam is to be 103 feet high, flood back sixteen miles and have a storage capacity of 3.6 billion cubic feet.

The site of dam No. 5 is on French Creek three miles above Franklin City. The dam will be seventy-five feet high, flood back nineteen miles and have a capacity of 3.3 billion cubic feet. The site of dam No. 6 is on the North Branch of French Creek in Erie county near Wattsburg. The dam will be sixty-seven feet high, flood back nine miles and store 2.1 billion cubic feet.

The site of dam No. 7 is on the Clarion River just above the mouth. The dam will be 142 feet high, flood back twenty-four miles and have a capacity of 5.1 billion cubic feet. The site of dam No. 8 is on the Clarion River four miles above Clarion borough. The dam will be 128 feet high, flood back twenty-three miles, and have a capacity of 4.9 billion cubic feet. The site of dam No. 9 is on the Clarion River two miles above Clarington, the dam will be seventy feet high, flood back fourteen miles and store 1.5 billion cubic feet.

The site of dam No. 10 is on Mahoning Creek twenty miles above the mouth. The dam will be 143 feet high, flood back fourteen miles and store 2.4 billion cubic feet.

The site of dam No. 11 is on Crooked Creek at the mouth. The dam will be ninety-four feet high, flood back fourteen miles and have a capacity of 3.3 billion cubic feet.

The site of dam No. 12 is on the Loyalhanna Creek one mile above the mouth. The dam will be 122 feet high, flood back nineteen miles and store 4.1 billion cubic feet.

The site of dam No. 13 is on Black Lick Creek at its mouth. The dam will be sixty-three feet high, flood back ten miles and have a capacity of 1.5 billion cubic feet.

Of the fifty-three floods, four occurred in December, eleven in January, thirteen in February, eleven in March and three in April, four in May, two in June, two in July, two in August, none in September, none in October and one in November. There has been no increase in amount or intensity of rainfall during the period covered by these floods and it is therefore evident that the increase in the frequency and height of floods has been due to artificial causes. The following table is taken from the Flood Commission Report:

TABLE V.—Increase of Floods at Pittsburgh since 1871, by Five-Year Periods.

Five Year Period.	Number of Floods.				
	22 ft. to 26 ft.	26 ft. to 30 ft.	30 ft. to 35 ft.	35 ft. to 40 ft.	Total.
1871-1875,	2	0	0	0	2
1876-1880,	3	0	0	0	3
1881-1885,	2	2	1	0	6
1886-1890,	7	1	0	0	8
1891-1895,	6	0	1	0	7
1896-1900,	3	3	0	0	5
1901-1905,	5	4	2	0	11
1906-1910,	8	1	1	1	11
Total,	36	11	5	1	53

Extensive deforestation of the drainage area has probably caused a higher rate of run-off. The carrying capacity of the river channel has been reduced by a gradual filling up and the construction of bridge piers and encroachments by filling and retaining walls, all have played some part in the increased height of floods.

With respect to the effect of storage reservoirs on the flow of the streams in the Allegheny Basin, the Pittsburgh Flood Commission has the following to say in its report:

"The greatest flood in this river at Kittanning since 1865 was that of March, 1905, which was only about six inches below the earlier flood. The crest of the 1905 flood reached, at Kittanning, a gage height of 28.8 feet, corresponding to a discharge of 240,250 second-feet. The proposed reservoir control above Kittanning would have reduced this gage height to 17.3 feet, or 99,550 second-feet discharge; a reduction in stage of 11.5 feet and in discharge of 140,700 second-feet.

"The flood of February 16th, 1908, which reached a stage of 24.8 feet at Kittanning, would have been reduced to a stage of 16.2 feet, a reduction of 8.6 feet. The flood of March, 1907, though the greatest on record at Pittsburgh, reached a stage of only 15.9 feet at Kittanning, as the rain-fall in the upper Allegheny was very light. This flood has, therefore, not been considered in this connection.

"The reductions in stage of the floods of 1905 and 1908, would be about the same amounts as at Kittanning as far up as Oil City, and from Kittanning to Pittsburgh, a total distance of about 134 miles. It is obvious what this would mean to present sufferers from floods along this river. At Kittanning, for example, overflow of the banks does not begin until the gage is well above 20 feet, whereas it would probably never exceed 18 feet with the proposed reservoir control."

Section 2.—Measurements.

Gauging stations are maintained at many points in the Allegheny Basin by the State Water Supply Commission. These were necessarily established at convenient points and therefore the measurements given in the tables do not include the flow from those portions of the drainage areas below the respective stations. The drainage areas in the tables of this Part are as computed by the Pittsburgh Flood Commission.

The monthly discharge in hundred second-feet of the Allegheny River at three points along its course is given in Tables VI, VII, and VIII.

TABLE VI—Monthly Discharge in Hundred Second-Foot of Allegheny River at Red House, New York. (Drainage Area 1,640 Square Miles.)

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	The Year.
Maximum Discharge.													
1904.	281	246	268	138	104	98	53	20	26	34	13	15	200
1905.	33	30	340	19	43	29	52	15	11	31	97	104	107
1906.	133	28	138	13	43	29	52	15	11	31	97	104	107
1907.	31	28	138	13	43	29	52	15	11	31	97	104	107
1908.	31	28	138	13	43	29	52	15	11	31	97	104	107
1909.	132	104	119	248	246	52	14	3	2	13	22	11	273
1910.	419	174	419	174	123	22	15	6	46	20	51	97	346
1911.	157	65	127	127	41	48	11	138	.....	.....	.....	.....	410
1912.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	156
Minimum Discharge.													
1904.	29	13	24	28	13	6	6	4	4	11	6	1	6
1905.	7	19	21	22	8	7	6	3	1	7	7	9	9
1906.	17	9	4	20	14	4	1	3	1	9	15	15	1
1907.	17	6	6	13	20	11	6	1	1	4	9	1	1
1908.	11	5	28	29	31	9	4	4	1	3	1	1	1
1909.	7	16	19	30	14	12	2	3	1	3	13	13	1
1910.	.....	.....	41	41	15	15	3	3	.....	.....	.....	.....	1
1911.	15	15	15	27	10	7	2	.....	.....	.....	.....	.....	1
1912.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Mean Discharge.													
1904.	.....	.....	112	69	39	21	16	8	9	20	8	21	21
1905.	45	25	107	29	12	29	29	16	5	13	23	48	28
1906.	27	12	67	26	28	10	3	8	5	27	29	59	26
1907.	56	16	61	40	38	27	17	8	4	22	17	28	27
1908.	29	10	103	58	63	24	13	3	2	22	9	4	31
1909.	41	86	103	54	75	29	6	8	3	25	6	6	30
1910.	.....	.....	137	63	49	14	6	3	10	7	29	21	33
1911.	85	31	44	59	20	15	5	17	.....	.....	.....	.....	.....

TABLE VII.—Monthly Discharge in Hundred Second-Foot of Allegheny River at Kittanning. (Discharge Area 9,010 Square Miles.)

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	The Year.
Maximum Discharge.													
1904.	884	.....	2,402	429	202	386	486	.....	76	138	53	560	.....
1905.	.....	.....	.....	624	196	337	291	230	214	251	530	771	.....
1906.	153	153	691	530	386	379	190	252	48	245	323	573	691
1907.	665	119	865	1,147	616	271	258	76	58	211	312	848	.....
1908.	450	1,902	1,147	450	1,823	292	76	46	13	12	16	192	665
1909.	730	1,053	1,568	1,850	1,823	292	76	28	13	38	166	126	1,053
1910.	836	1,269	1,501	567	268	139	33	18	138	191	319	757	1,269
1911.	1,187	678	437	475	221	90	58	691	780	1,259	.....	.....	1,259
Minimum Discharge.													
1904.	113	.....	.....	96	.....	.....	.....	.....	16	26	21	21	.....
1905.	110	56	344	88	46	42	37	39	24	31	73	67	.....
1906.	58	58	63	84	58	28	15	16	16	24	73	92	15
1907.	105	58	110	158	110	73	35	10	12	39	61	51	10
1908.	61	101	116	145	166	44	42	13	8	8	8	13	8
1909.	64	119	145	145	166	51	19	9	8	9	15	13	8
1910.	7	106	199	58	67	23	14	11	12	19	113	44	11
1911.	114	105	37	153	55	25	12	10	58	76	.....	.....	.....
Mean Discharge.													
1904.	430	.....	.....	188	.....	140	167	.....	20	60	89	106	.....
1905.	.....	.....	.....	703	104	66	50	87	62	112	147	204	.....
1906.	279	77	167	291	297	163	73	61	26	132	170	263	.....
1907.	378	86	379	291	297	163	73	31	31	102	179	229	140
1908.	199	406	592	279	371	95	91	27	10	10	12	24	177
1909.	272	403	279	281	338	120	32	14	9	19	33	66	156
1910.	257	173	623	181	142	71	20	13	43	40	136	153	169
1911.	454	268	190	291	96	55	19	68	221	276	.....	.....	191

TABLE VIII.—Mean Discharge in Hundred Second-Feet. Allegheny River at Mouth, Pittsburgh. (Drainage Area 11,580 Square Miles.)

Month.	1903.	1904.	1905.	1906.	1907.	1908.
Mean Discharge.						
January,	22,300	28,400	10,000	30,400	55,400	23,500
February,	53,100	24,000	3,500	9,800	8,620	30,500
March,	63,600	70,000	62,200	23,800	56,500	71,000
April,	30,600	30,200	21,400	37,800	20,800	32,300
May,	9,500	28,100	16,300	11,100	21,600	41,400
June,	18,800	24,200	16,100	10,300	21,000	10,800
July,	20,100	24,200	15,600	5,800	9,700	.....
August,	21,800	20,000	16,500	11,000	8,000	.....
September,	21,300	21,100	9,100	5,100	6,500	.....
October,	20,000	23,700	17,800	27,300	13,400	.....
November,	21,300	20,100	19,600	35,000	19,100	.....
December,	9,500	11,000	38,500	41,800	24,100	.....
The Year,	26,750	28,100	20,000	22,100	22,800	.....

The next five tables give the maximum, minimum and mean discharges of the five main tributaries of the Allegheny River from in the vicinity of Warren, to Franklin City.

TABLE IX.—Monthly Discharge in Hundred Second-Foot of Kinzua Creek at Dewdrop. (Drainage Area 162 Square Miles.)

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum Discharge.												
1909.	20.3	28.4	32.3	11.9	9.4	6.3	2.6	9	1.0	1.7	3.60	4.37
1910.	24.8	14.8	13.2	12.0	5.2	3.6	1.5	6.7	12.6	.....	4.4	15.0
1911.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Minimum Discharge.												
1909.	1.63	2.86	4.55	1.7	1.7	.6	.32	.92	.....	.....	.4	.6
1910.	2.71	1.92	1.45	3.6	.53	.68	.13	.15	.20	.21	.67	1.63
1911.	.....	.....	.....	.....	.....	.....	.....	.....	.64	.....	.....	.....
Mean Discharge.												
1909.	6.4	7.2	12.6	4.3	4.1	2.2	.7	.34	.....	.....	1.0	1.44
1910.	9.7	4.5	4.4	6.5	1.9	1.6	.3	.87	.41	.5	2.0	3.2
1911.	.....	.....	.....	.....	.....	.....	.....	.....	3.81	.....	.....	.....

TABLE X.—Monthly Discharge in Hundred Second-Foot of Conewango Creek at Frewsburg, N. Y. (Drainage Area 550 Square Miles.)

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum Discharge.												
1909,	44.1	55.1	106.8	16.8	31	10	3.3	3.5	13.7	.....	7.9	7.9
1910,	115.2	51.8	26.2	35.5	17	4	2.9	33.3	25.6	11	50.7	35.9
1911, .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Minimum Discharge.												
1909,	4.4	7.4	10.3	4.9	4	2.8	2.3	2.1	2.3	.....	2.6	3.0
1910,	9.3	7.2	6.5	5.2	2.3	2.6	1.9	2.1	3.0	.....	5.9	6.6
1911, .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Mean Discharge.												
1909,	15.9	12.1	48.2	7.4	8.1	5.5	2.7	2.4	3.9	.....	3.8	4.2
1910,	42.2	16.3	12.5	11.8	6.2	3.0	2.3	5.9	6.7	4.3	18.4	11.6
1911, .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE XI.—Monthly Discharge in Hundred Second-Foot of Brokenstraw Creek at Youngsville. (Drainage Area 290 Square Miles.)

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum Discharge.												
1909.	30.5	56.7	71.6	11.1	23.0	31.6	1.9	1.8	11.9	11.2	7.8	8.4
1910.	45.7	39.1	23.9	27.9	13.3	2.6	0.8	39.9	—	—	26.9	29.2
1911.	—	—	—	—	—	—	—	—	—	—	—	—
Minimum Discharge.												
1909.	2.1	3.9	3.9	2.1	2.1	1.4	0.9	0.7	6.7	1.6	1.2	1.4
1910.	4.7	2.7	3.0	3.8	1.4	0.5	0.3	0.3	—	—	5.6	5.1
1911.	—	—	—	—	—	—	—	—	—	—	—	—
Mean Discharge.												
1909.	8.6	7.2	22.5	4.5	—	3.5	1.3	0.9	—	—	2.5	2.0
1910.	20.0	9.5	9.1	10.1	3.5	1.4	0.5	2.3	2.9	4.1	13.5	7.6
1911.	—	—	—	—	—	—	—	—	—	—	—	—

TABLE XII.—Monthly Discharge in Hundred Second-Foot of Tionesta Creek at Nebraska. (Drainage Area 451 Square Miles.)

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum Discharge.												
1909.	43.7	64.0	73.9	83.1	22.7	30.0	10.7	2.1	3.4	4.2	3.8	11.9
1910.	92.0	34.8	33.1	39.2	17.8	9.9	1.4	37.7	46.8	.....	11.4	46.4
1911.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Minimum Discharge.												
1909.	2.0	2.1	11.9	2.8	5.1	2.2	1.8	1.4	1.3	1.5	0.8	0.8
1910.	4.1	0.9	2.0	7.8	1.1	0.8	0.5	0.5	2.1	.....	2.5	3.7
1911.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Mean Discharge.												
1909.	10.9	7.7	34.2	9.9	12.1	8.2	2.5	1.6	1.7	2.0	1.4	2.6
1910.	26.0	11.6	17.5	18.1	4.1	2.2	0.7	3.8	13.1	.....	6.2	9.7
1911.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE XIII.—Monthly Discharge in Hundred Second-Foot of Oil Creek at Rouseville. (Drainage Area 302 Square Miles.)

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum Discharge.												
1909,	44.9	63.6	83.7	29.8	23.8	17.1	1.3	.....	1.2	.....	6.7	11.8
1910,	61.8	40.8	20.6	28.0	9.0	6.7	1.1	.....	.....	5.2	23.8	35.8
1911, .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Minimum Discharge.												
1909, .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1910, .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1911, .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Mean Discharge.												
1909, .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1910, .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1911,	16.7	6.2	21.8	1.9	4.8	3.4	6.8	6.1	2.6	1.7	1.4	1.3
		8.8	7.4	9.4	2.2	1.2	6.5	3.0	.....	.....	8.9	5.6

The next four tables show the discharge of French Creek at Carlton thirteen miles above Franklin City, the mouth, and on the North Branch, far up the basin, and on the tributary Cussewago Creek, and also on the tributary Sugar Creek which joins French Creek near Franklin City.

TABLE XIV.—Monthly Discharge in Hundred Second-Feet of French Creek at Carlton. (Drainage Area 1,070 Square Miles.)

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum Discharge.												
1908.	135	121	87	123	57	29	8	5	7	—	—	—
1909.	143	111	87	123	222	35	9	3.9	1.8	4.6	1.4	37
1910.	143	111	296	53	47	38	2.6	2.0	8.8	28	32	32
1911.	172	100	44.6	66	29	3.8	2.5	64	86	11.5	97.8	83
Minimum Discharge.												
1908.	—	—	—	—	—	—	—	—	—	—	—	—
1909.	10.2	6.2	11.2	9.4	8.8	2.8	2.5	7	5	5	7	1.1
1910.	32.0	14.6	8.4	4.3	4.2	4.8	1.4	1.3	1.3	1.2	1.4	3.6
1911.	13.8	10.2	9.8	8.4	2.0	2.0	1.4	1.1	3.8	1.2	11.2	9.8
Mean Discharge.												
1908.	—	—	—	—	—	—	—	—	—	—	—	—
1909.	28.8	50.5	35.8	25.0	28.6	6.8	4.1	1.8	0.6	0.7	1.0	7.1
1910.	57.9	34.0	77.3	12.6	38.5	13.6	3.7	1.6	1.3	2.0	7.0	15.6
1911.	69.6	36.7	24.7	26.6	15.2	8.9	1.5	1.2	2.4	4.8	44.2	23.4
						3.2	1.6	6.9	19.4	30.4	—	—

TABLE XV.—Monthly Discharge in Hundred Second-Feet of North Branch of French Creek at Kimmetown. (Drainage Area 212 Square Miles.)

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum Discharge.												
1910.						8.9	1.1	.9	7.6	7.1	65.7	18.9
1911.	91.9	38.4	18.9	23.4	6.7	1.8	.70	12.8				
Minimum Discharge.												
1910.						.57	.45	.44	.41		3.5	4.2
1911.	3.1	2.4	1.8	1.8	.70	.70	.44	.41				
Mean Discharge.												
1910.						2.5	.63	.49	1.5	1.5	11.0	8.0
1911.	17.0	8.0	7.1	6.5	1.9	1.0	.52	1.5				

TABLE XVI.—Monthly Discharge in Hundred Second-Foot of Cussewago Creek near Meadville. (Drainage Area 102 Square Miles.)

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum Discharge.												
1910, .....	.....	.....	.....	.....	7.1	5.8	.55	.09	.16	3.1	7.5	8.1
1911,	6.2	7.3	3.3	6.0	2.1	1.6	.22	6.1	.....	.....	.....	.....
Minimum Discharge.												
1910, .....	.....	.....	.....	.....	.34	.03	.02	.02	.02	.02	1.2	1.3
1911, .....	.18	.43	.59	.24	.03	.05	.02	.02	.....	.....	.....	.....
Mean Discharge.												
1910, .....	.....	.....	.....	.....	1.3	.83	.04	.03	.05	.55	4.3	2.7
1911,	4.6	2.2	1.6	1.8	1.2	.26	.06	.42	.....	.....	.....	.....

TABLE XVII.—Monthly Discharge in Hundred Second-Foot of Sugar Creek at Wyntville. (Drainage Area 159 Square Miles.)

Year.	Jan.	Feb.	Mar.	Apr.	May.	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum Discharge.												
1910.	20.2	8.9	3.8	11	1.1	5.6	.7	.3	.7	1.4	11.7	17.8
1911.					2.2	.4	.2	11	28.2			
Minimum Discharge.												
1910.	.71				.33	.26	.26	.20	.20	.26	1.1	1.4
1911.		.71	.55	.90	.20	.09	.11	.14	.20			
Mean Discharge.												
1910.	6.8	2.5	1.5	2.9	.53	.85	.36	.25	.32	.70	3.8	3.8
1911.					.50	.22	.16	.77	3.3			

The next four tables show the discharge of the Clarion River, Red Bank Creek, Mahoning Creek, and Crooked Creek. These streams are main tributaries of the Allegheny River.

It is on the Clarion River that very large water development power projects have been approved. There are large industrial interests located in this valley and the waters are not suitable for domestic purposes along the lower stretches of the river. The Red Bank Creek is used as a source of water supply. The facts as to the occupation of each water shed of the four streams and other relevant data appear elsewhere in this report.

TABLE XVIII.—Monthly Discharge in Hundred Second-Foot of Clarion River at Clarion. (Drainage Area 910 Square Miles.)

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum Discharge.												
1904.	278	192	261	258	169	33	135	23	12	22	6	...
1905.	138	36	393	46	26	41	75	26	42	82	93	162
1906.	109	41	95	129	23	16	7	14	14	23	25	109
1907.	169	138	153	98	33	33	26	4	23	36	55	138
1908.	82	229	211	77	109	52	166	12	2	1	1	31
1909.	98	168	70	315	212	7	35	2	1	7	1	1
1910.	261	312	223	75	26	23	9	2	6	6	26	109
1911.	186	63	61	72	57	31	4	267	138	...	...	...
Minimum Discharge.												
1904.	6.6	10.8	11.2	14.2	10.0	10.8	7.2	2.5	1.4	3.2	1.2	...
1905.	17.1	1.9	1.9	6.6	8.8	9	3.1	3.9	3.2	4.9	19.6	12.4
1906.	19.3	11.1	22.3	18.6	10.8	10.8	1.0	1.0	2.8	2.6	5.4	12.4
1907.	22.8	21.6	22.9	28.6	19.3	8.6	7.9	2.8	1.9	6.6	6.6	5.4
1908.	20.1	21.2	19.2	14.2	2.8	2.5	2.2	2.8	1.2	1.0	1.0	1.0
1909.	18.2	29.8	19.2	14.2	7.9	3.2	3.8	1.1	1.1	1.1	1.1	6.6
1910.	6.6	6.6	20.4	18.2	4.9	2.8	3.2	1.3	8.6	...	...	...
1911.	19.9	10.9	7.2	...	...	...	...	...	...	...	...	...
Mean Discharge.												
1904.	32	31	79	50	31	17	28	7.6	4.0	8.5	2.6	...
1905.	56	13	80	19	15	17	29	12	15	26	29	41
1906.	36	26	23	42	17	9.5	12.3	4.6	5.4	12.6	15	39
1907.	49	66	56	21	21	19	12	1.6	8.8	16	18	23
1908.	31	49	86	39	48	19	21	6.8	1.3	7	1.2	8.4
1909.	42	67	39	45	63	4.2	3.3	1.8	1.3	1.5	1.5	1.2
1910.	57	27	73	21	15	9.0	3.2	1.5	2.5	2.2	8.1	15
1911.	53	24	21	38	10	6.1	2.7	19	41	...	...	...

TABLE XIX.—Monthly Discharge in Hundred Second-Foot of Red Bank Creek at St. Charles. (Drainage Area 540 Square Miles.)

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum Discharge.												
1909.	131	140	105	55	8.4	5.3	3.5	2.5	45	3.4	1.9	10.9
1910.	105	52	11	32	8.5	1.1	1.0	81.9	128	191	13.9	88.8
1911.	100										24.7	52.7
Minimum Discharge.												
1909.	2.03	3.73	5.36	3.65	2.06	.42	.13	.10	.17	.36	.21	.32
1910.	3.13	3.01	2.69	5.56	.40	.31	.12	.12	2.57	3.65	1.89	2.65
1911.											2.72	2.45
Mean Discharge.												
1909.	33	13	32	10	4.4	2.6	.33	.37	5.6	1.5	0.6	3.7
1910.	23	12	7.7	15.1	2.5	.61	.49	7.68	23.2	24.5	4.6	8.3
1911.	25										7.5	13.8

TABLE XX.—Monthly Discharge in Hundred Second-Foot of Mahoning Creek at Furnace Bridge. (Drainage Area 412 Square Miles.)

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum Discharge.												
1910,	48	126	117	92	19	4.4	1.5	2.8	53.1	5.0	11.2	90
1911,	160	49	20	40	5.2	2.5	0.3	15.4	.....	.....	.....	.....
Minimum Discharge.												
1910,	3.2	1.2	5.7	2.0	2.0	1.7	.22	.03	.18	.29	1.6	1.6
1911,	8.5	7.0	7.0	7.6	1.2	1.2	1.1	1.1	.....	.....	.....	.....
Mean Discharge.												
1910,	18	20	47	17	6.7	2.6	.3	.2	13.2	1.6	3.3	13.3
1911,	34	22	10	19	1.5	.1	.2	1.8	.....	.....	.....	.....

TABLE XXI.—Monthly Discharge in Hundred Second-Foot of Crooked Creek at Hilemans Farm. (Drainage Area 729 Square Miles.)

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum Discharge.												
1909,				25	2.1	.7	1.2	.3	8.5		.3	8.5
1910,			61	13.2	6.3	6.7	1.2	.3	1.2		4.9	59
1911,	99	12	4.5				.7	.7	121			
Minimum Discharge.												
1909,												
1910,			56	21	.54	.29	.10	.01	.03		.1	.1
1911,	1.7	2.6	2.0	2.1	.46	.09	.06	0	.01	.20	.25	.73
Mean Discharge.												
1909,												
1910,			8.4	3.8	.9	.6	.5	.1	1.4		.9	.7
1911,	11.7	5.2	2.9	8.5	1.9	1.3	.39	.1	7.8	.6		5.1

The next three tables give the discharges of the Kiskiminetas River and two of its main tributaries, the Black Lick Creek and Loyallhanna Creek.

TABLE XXII.—Monthly Discharge in Hundred Second-Feet of Kiskiminetas River at Avonmore. (Drainage Area 1,720 Square Miles.)

Year.	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum Discharge.												
1907.	174	45	35	81	42	122	291
1908.	397	672	150	182	32	33	9	7	1	3	69
1909.	237	193	173	134	146	11	12	1	27	4	47
1910.	158	311	172	37	169	41	69	31	5	17	138
1911.	89	61	202	38	32	8	69	316	131	.....	.....
Minimum Discharge.												
1907.	19	8	4	6	6	11	9
1908.	11	21	17	25	4	3	2	1	1	1	1
1909.	11	20	31	8	5	2	1	1	1	3	2
1910.	23	12	5	10	9	12	1	1	2	2	8
1911.	17	55	28	4	4	2	1	9	13	.....	.....
Mean Discharge.												
1907.	39	18	11	23	17	37	51
1908.	108	139	57	61	11	7	4	1	1	1	7
1909.	60	56	67	36	25	4	4	2	5	3	29
1910.	121	68	27	18	29	7	2	7	2	4	28
1911.	89	37	61	13	12	4	6	46	49	.....	.....

TABLE XXIII.—Monthly Discharge in Hundred Second-Foot of Black Lick Creek at Black Lick. (Drainage Area 386 Square Miles.)

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum Discharge.												
1904.	.....	.....	85	33	16	33	17	11	43	84	1.9	.....
1905.	.....	.....	196	14	13	33	5.5	1.9	18	13	86	128
1907.	101	19	130	33	53	6.2	13	2.2	.4	.4	29	58
1908.	48	113	63	63	73	38	10	2.7	.6	3.0	6	37
1909.	26	89	63	47	10	8.5	59	1.1	.3	2.4	1.4	12
1910.	173	117	78	35	7.9	6.8	.8	8.8	.....	.....	6.4	71
1911.	92	24	10	35	.....	.....	.....	.....	.....	.....	.....	.....
Minimum Discharge.												
1904.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1905.	.....	.....	6.6	3.2	1.6	2.1	1.3	1.3	.34	.38	.37	.....
1907.	6.6	5.0	4.4	4.1	2.1	2.2	1.1	.43	.73	.35	2.4	2.8
1908.	4.1	3.0	6.6	4.7	4.1	1.4	.7	.33	.09	1.4	2.8	2.1
1909.	7.2	4.1	5.0	5.0	1.9	1.8	.6	.37	.18	.20	.20	.2
1910.	1.3	4.3	2.3	1.4	2.2	1.2	.3	.37	.27	.13	.60	.8
1911.	4.5	4.3	4.6	5.6	.9	1.5	.23	.16	.....	.....	.8	2.4
Mean Discharge.												
1904.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1905.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1907.	6.7	10.7	39	9.4	4.9	8.5	1.2	3.5	3.9	9	7.8	17
1908.	.....	14.5	32	12	5.4	7.0	2.5	.9	1.9	3.5	7.9	11
1909.	9.3	18	15	16	17	2.8	2.1	.9	.2	.3	.5	3
1910.	8.5	15	16	16	10	6.9	1.6	1.0	.4	.9	1.0	.8
1911.	30	15.5	16	7.0	4.6	4.3	2.0	.5	8.2	.9	1.5	9
1911.	21	11	7.4	14	2.5	1.8	.5	1.0	.....	.....	.....	.....

TABLE XXIV.—Monthly Discharge in Hundred Second-Foot of Loyahanna Creek at New Alexandria. (Drainage Area 256 Square Miles.)

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum Discharge.												
1910,	29.8	.....	.....	18.2	6.7	8.7	8.7	7.3	.....	1.73	5.5	3.2
1911, .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Minimum Discharge.												
1910, .....	.72	.....	2.9	3.4	.80	.49	.20	.15	.....	.18	.22	.58
1911, .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Mean Discharge.												
1910,	5.7	.....	4.4	7.6	2.1	1.6	1.1	.8	.....	.28	.91	3.2
1911, .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Table XXV is a summary of the maximum and minimum discharges of the Allegheny River and its tributaries as given in detail in the preceding tables. For convenience and comparison in the columns of maximum and minimum discharge the second-feet are given total and also for the square mile and the drainage area of each stream is also given.

TABLE XXV.—Maximum and Minimum Discharge of Allegheny River and Tributaries.

Stream.	Maximum Discharge.		Minimum Discharge.		Drainage Area Sq. Mile.
	Sec. ft.	Sec. ft. per Sq. Mile.	Sec. ft.	Sec. ft. per Sq. Mile.	
Allegheny River:					
Red House,	41,000	25.00	100	0.060	1,640
Kittanning,	240,500	26.70	775	0.086	9,619
Pittsburgh,	300,000	26.60	950	0.082	11,550
Kinzua Creek:					
Dewdrop,	7,660	47.30	13	0.080	162
Mouth,	8,000	.....	.....	.....	169
Conewango Creek:					
Mouth,	33,000	37.00	145	0.160	892
Brokenstraw Creek:					
Mouth,	14,350	45.00	45	0.140	319
Tionesta Creek:					
Nebraska,	20,600	45.00	38	0.084	451
Mouth,	21,750	.....	40	.....	477
Oil Creek:					
Houseville,	15,000	49.50	39	0.130	302
French Creek:					
Carlton,	48,700	45.50	50	0.047	1,076
Mouth,	50,330	.....	58	.....	1,238
North Branch,					
Klunmeyer town,	12,000	56.50	20	0.094	212
Cussewago Creek:					
Mouth,	5,000	47.60	3	0.029	105
Sugar Creek:					
Wyattville,	8,000	50.20	9	0.057	159
Clarion River:					
Clarion,	39,200	43.10	50	0.055	910
Mouth,	52,400	.....	.....	.....	1,213
Red Bank Creek:					
St. Charles,	25,000	46.20	10	0.019	540
Mouth,	27,000	.....	11	.....	585
Mahoning Creek:					
Purnace Bridge,	18,750	45.50	20	0.049	412
Mouth,	19,000	.....	.....	.....	417
Crooked Creek:					
Mouth,	14,000	48.80	1	0.004	287
Kiskiminetas River:					
Avonmore,	80,000	46.50	65	0.038	1,720
Black Lick Creek:					
Black Lick,	19,620	50.80	6	0.016	386
Mouth,	21,000	.....	7	.....	414
Loyalhanna Creek:					
Mouth,	14,180	51.00	10	0.036	273

Section 3.—Relation of Precipitation to Run-off.

The mean annual rain-fall in the Allegheny basin, as previously shown is 42.35 inches. The lowest mean annual rainfall on the Allegheny basin, 37 to 39 inches, is in the extreme northern portion, near Lake Erie. From here it increases southwardly to 46.4 inches at Clarion, on the Clarion River. At Johnstown, on the Conemaugh, in the southern part of the basin, the average is 45.1 inches, increasing further up this stream to an average of 48 inches near the source. The lowest mean annual rainfall recorded is at Pittsburgh, 36.1 inches, or 6.3 inches below the average for the basin and the greatest

is at Clarion, 4.06 inches above the average for the basin; giving a difference of 10.36 inches between the greatest and least mean annual rainfall on the basin.

The Clarion and Kiskiminetas basins receive a greater rainfall than those of any other tributaries of the Allegheny River.

The minimum annual rainfall recorded, occurred in 1887, at Saltsburg on the Kiskiminetas, when the total precipitation for the year was only 22.3 inches, or 16.4 inches below the mean annual rainfall at that station. The maximum annual rainfall occurred in 1870, at Franklin on the Allegheny, when the total precipitation for the year was 59.7 inches, or 18.8 inches above the mean at that station.

With respect to the seasonal distribution, which has an important relation to the run-off and stream flow, on the Allegheny basin, the average spring rain-fall is 10.3 inches, summer 12.6 inches, and winter 9.5 inches. This uniform seasonal distribution aids the streams in maintaining their flow. During the winter months, the precipitation is largely in the form of snow and sleet, and the ground surface is frozen; so that if the snow melts, much of it flows directly off in freshets. During the growing season much of the rain is absorbed by the dry ground and vegetation and the streams then reach their lowest stages.

July is the month of maximum rain-fall and June and May come next in order. The monthly rain-fall has exceeded ten inches sixteen times on the Allegheny basin and several times it has exceeded fifteen inches.

The greatest rain-falls recorded for twenty-four hours at stations on the Allegheny basin were as follows: Johnstown, 4.49 inches, Parker, 3.75 inches, Pittsburgh 4.08 inches and Warren 3.56 inches. At Erie it was 4.71 inches.

Section 4.—Relation of Forest Conditions to Run-Off.

The wearing down of the plateau region of the Allegheny basin and the cutting of deep gorges by the streams have been going on for ages. Abnormal soil erosion however, does not exist to a large extent on the watershed. There are places where fields and roadways have gullied, and where stream banks have washed away accompanied by excessive turbidity of the waters. Generally speaking, where the forest conditions are undisturbed and the vegetable covering of the soil has not been burned, erosion does not occur and the streams run clear. Even where the forests have been extensively lumbered and fires have burned periodically at the head water streams in the basin, the waters are clear.

The tributaries to the east of the Allegheny River, flow in narrower and more rugged valleys—frequently on solid rock beds. Notably in the Clarion and Kiskiminetas rivers, unusually huge rocks have fal-

len down the slopes and into the stream bed. With the exception of the lower Kiskiminetas, nearly all the eastern valleys are comparatively thinly settled. Whatever cultivation there is will be found mostly on the uplands.

The tributaries to the west of the Allegheny River, have larger valleys that are more open and more cultivated. In the glacial region, some of the larger streams meander sluggishly through long reaches of nearly level bed, where extensive swamps lying over flooded valleys are found.

The tributaries flowing through agricultural areas have less clear waters. The clearing of the land favors soil erosion. Gullying will take place on badly tilled slopes and along steep roadways. Where the soil begins to wash, erosion may be remedied by attention to rational systems of cultivation.

It is the waste land in the coal mining districts about which concern should be manifest with respect to stream flow phenomena. In the basins of the Conemaugh and its head waters in Cambria County, the Kiskiminetas and Loyalhanna, near the head waters of the Mahoning in southern Jefferson County and in parts of many other drainage areas where coal mining is now carried on or where the coal has been taken out and the lands abandoned, the waste areas are too poor for cultivation or pasture. They are desolate regions, rocky and growing up with shrubs scattered among vines and weeds. Fires sweep over these areas which are neglected and in time, if reforestation is not promoted, extensive erosion will occur.

In and about McKean County and along the Allegheny Divide, including the northeastern Allegheny head waters, there are vast areas of denuded and burned forest lands on the sandstone and conglomerate plateaus which rapidly shed the rainfall and add to the disastrous flood conditions of the streams draining them. These conditions are constantly becoming worse.

In no region of the country have the natural forest conditions been more disturbed than in the Allegheny basin. In Clearfield, Jefferson, Indiana, and Cambria counties the clearing of new land is going on wherever the soil is fertile with a consequent greater yield of run-off. Probably the great area of rough wooded lands in McKean, Warren, Forest, and Elk counties will always remain as forest lands. What is needed here is tree planting and forest land protection from fire. Re-planting should be practised in the great areas in the coal mining district.

Section 5.—Relation of Flow to Sanitation and Water Supply.

The Allegheny River is extensively used as a source of water supply for domestic and industrial purposes. The waters are dangerously polluted with the sewage of thickly populated communities and

impregnated with mine drainage and manufactural wastes. The hardness of the water necessitates artificial softening before its use for steaming purposes. The mineral constituents of the water which are added principally by the operations of man living on the basin, exert their most objectionable influence during periods of low flow. The conditions improve as the volume of flow in the river increases.

With respect to dilution, the Pittsburgh Flood Commission has the following to say:

"It is evident that the improvement of the conditions of the rivers through dilution of their sewage burden at times of low water would be considerable. At Pittsburgh, for example, where a combined population of about 583,000 discharges sewage into the rivers, the minimum Ohio River flow of about 1,200 second-feet is only about 2 cubic feet per second per 1,000 of population, whereas the minimum dilution considered permissible, if nuisance and odor are to be avoided, is usually taken at 3.33 cubic feet per second for each 1,000 persons contributing to such sewage discharge. With the lowest estimate of the increased flow that could be obtained by the storage reservoirs, this minimum dilution would be about 8 cubic feet per second per 1,000 inhabitants.

"On the Allegheny, at Kittanning and Freeport, as has been shown, the minimum flow would be over three times its present amount; and on the Kiskimincus at Avonmore, it would be six times the present minimum discharge. The sewage of practically all the towns bordering the rivers passes into the streams without purification, and the conditions, owing to the concentration of sewage and other wastes during low water, are yearly becoming more serious. Such an increase in low-water flow would very considerably dilute this sewage and greatly improve the quality of the water for domestic and industrial supply, even though no complete purification of sewage be provided."

Section 6.—Relation of Flood Control to Navigation.

As will appear elsewhere in this report, the navigation of the Allegheny River and its tributaries is of great importance commercially and industrially to the people and improvements extensive and far reaching in benefits are contemplated.

At present only twenty-four miles of the Allegheny, between Pittsburgh and Natrona, are slackwatered. Plans for extending the canalization of the river to Oil City, 134 miles above Pittsburgh, have been prepared by the Federal Government engineers, and the construction of locks and dams has been begun. The second navigation dam is at Aspinwall and the third dam is at Springdale. The storage proposed in the thirteen reservoir projects on the Allegheny basin briefly described before, would increase the low-water stage between Oil City and Pittsburgh by about 1.4 feet. This would greatly improve the present intermittent open-river navigation above Tarentum and would insure a pool-full stage and uninterrupted navigation throughout the year when the slack water system of dams and locks is extended.

PART III

NATURAL RESOURCES, THEIR DEVELOPMENT AND EXTENT.

Section 1.—Timber, Tanneries, and Chemical Plants.

The mineral resources of the Allegheny basin are of enormous importance and have been largely exploited. The lumber, iron ore, petroleum, and natural gas industries have each had its reign. The presence of the timber and iron ore primarily attracted the early settler to the basin and caused the development of the lumber and iron industries. As the population increased, so likewise increased the manufacture of iron and the manufacture of lumber until these natural resources were depleted.

The nature of the soil renders it of lesser agricultural value except in comparatively small areas. Consequently vast sections which have been denuded of their timber, remain as they were left by the lumbermen. This outwardly barren region contains, however, mineral deposits of great value. Upon these mineral deposits and upon the development of the soil and water resources the people of the basin must depend for their future wealth and prosperity. Chief among the mineral deposits are bituminous coal, natural gas, petroleum, and the clays.

It should be noted that the coals and the iron ore and the natural gas and the petroleum deposits are not uniformly persistent throughout the basin. They vary in quality and extent and disappear entirely in some localities.

The pioneers of the Allegheny basin found the entire watershed covered with a dense growth of valuable forest. The early development of the northern and central portions of the basin was mainly based on lumbering. With the spread of settlement the seemingly inexhaustible supply of timber led to gross carelessness and enormous waste in cutting. Lumber operations gradually assumed greater and finally enormous proportions, reaching the maximum about 1895. As a result of the reckless methods practised, inattention to second growth, and devastating forest fires, no timber tracts of any considerable extent are found, with perhaps one exception,

to be noted below. The lumber industry is about to become a matter of history. A reliable estimate places the amount of timber sent down the Allegheny River in 1879 at 200 million B. M.

The abundance of hemlock early brought about the establishment of tanneries throughout the northern part of the basin, because the process of tanning then required great quantities of hemlock bark. Until about 1890 there was little market for hemlock lumber owing to the plentiful supply of other woods of better grades, and it was the universal practice to cut the timber for the bark alone, allowing the stripped timber to lie as it fell. As a result of such wastefulness, immense areas are now virtually strewn with dead logs. However, the diminishing supply of the more valuable wood brought hemlock into the market. The tanner and the lumberman have joined forces during the past twenty years to prevent the former wastes. Indeed some work is being profitably carried on in reclaiming the logs which were left to decay, but which in some cases still have sound hearts.

The original timber in the northern portion of the basin consisted mainly of hemlock and pine in the ravines and on the northern slopes of the hills, and hard woods—chiefly maple, beech and birch—on the ridges. In the central and southern sections of the basin, white oak and chestnut predominated, with some yellow pine on the southern exposures. The principal trees found in the extreme southern portion were white oak, red oak, rock oak, chestnut, ash, maple, beech, and locust.

The timber in the immediate vicinity of the larger streams in the central portion and throughout the southern counties of Westmoreland and Somerset, was practically exhausted by the early charcoal iron operations before the furnaces were finally abandoned—1858 to 1870.

The tract of timber above mentioned, lies in the Potato Creek region in McKean county, and it is by far the largest body of virgin timber now remaining in the State. It comprises about 40,000 acres and under the proposed system of lumbering will be exhausted in about ten years.

The rest of the standing timber in the basin is mostly in isolated areas; the larger part of these belonging to the tanning interests and the balance consists chiefly of farm wood lots. A small amount of white pine of excellent quality is still found in Forest County. Some beech, birch, and maple remain in the western part of Potter County; in Westmoreland County there is considerable second growth of chestnut and oak. Northeastern Somerset County furnishes some good hemlock timber.

Enough of these minor lumbering operations are going on to constitute a constant menace to the purity of those mountain streams that are used as a source of public water supply to the towns located

on head water streams. Not a few typhoid epidemics have been recorded in the history of sanitation in the basin as originating at lumber camps and transmitted by water to the people residing in the towns which rely for their drinking water on the streams that drain these camps.

In the Allegheny basin there are thirty-seven tanneries, seven of which are in New York State. All of these plants are located on the river or its tributaries above Mahoning Creek, thirteen being on the river proper, eight on the Clarion River, seven on Tionesta Creek, three on Red Bank Creek, two on Brokenstraw Creek and one each on Tunungawant, Oil, French, and Mahoning Creeks.

These tanneries discharge offensive dark brown wastes into the stream. Ridgway is the home of the Elk Tanning Company that operates all or most of the plants mentioned. That company's experts are endeavoring to find some method, within a reasonable outlay, by which the polluting material can be removed from the liquid and thus obviate the harm now done. The tannery waste now renders streams unfit for use by man or beast. Where the contamination is slight, so that cattle will drink the water, both horses and cows have been known to contract anthrax. Where the pollution is marked, fish are exterminated.

The west branch of the Clarion River is clear above the tannery and chemical plants; but below them it is foul and highly discolored. Elk Creek which enters the Clarion at Ridgway is black with tannery and mine wastes. The Clarion River above this point is dirty brown from the paper and pulp manufacturing wastes and tannery pollutions at Johnsonburg. Fish do not live in the Clarion.

Since chemical plants and paper mills require wood as raw stock, naturally the upper Allegheny basin is a favorable locality for these industries. There are forty-seven chemical plants of importance on the Allegheny watershed. Above Warren, there are thirty-two of these plants, two of which are in New York State.

Charcoal, wood alcohol and acetate of lime are largely manufactured. The waste products discharged to the stream strongly impregnate the waters with creosote taste and odor that can be detected many miles below the point of such discharge. The creosote pollution is so obvious at Warren, where the town obtains its water supply from the Allegheny, that the citizens demand a discontinuance of the discharge of all wastes from chemical plants into any waters.

TABLE XXVI.—List of Tanneries on the Allegheny Basin.

Town.	Company.	County.	Stream.	No. of Plants.
DuBois,	Van Tassel,	Clearfield,	Red Bank Creek,	1
Cambridge Springs,	Phelan & Ross,	Crawford,	French Creek,	1
Titusville,	Elk Tannery,	Crawford,	Oil Creek,	1
Arroyo,	Elk Tannery,	Elk,	Clarion River,	1
Instant,	Elk Tannery,	Elk,	Clarion River,	1
Johnsonburg,	Rolfe Tannery,	Elk,	Clarion River,	1
Portland Mills,	Elk Tannery,	Elk,	Clarion River,	1
Ridgway,	Elk Tannery,	Elk,	Clarion River,	1
St. Marys,	St. Marys Tannery,	Elk,	Elk Creek,	2
Wilcox,	Elk Tannery,	Elk,	Clarion River,	1
Brookston,	Elk Tannery,	Forest,	Tomesta Creek,	1
Kelleysville,	Elk Tannery,	Forest,	Tomesta Creek,	1
Hickory,	Hickory,	Forest,	Allegheny River,	1
Big Run,	Wm. Irving,	Jefferson,	Muhlenberg Creek,	1
Falls Creek,	Elk Tannery,	Jefferson,	Red Bank Creek,	1
W. Reynoldsville,	Elk Tannery,	Jefferson,	Red Bank Creek,	1
Edrol,	Eldred Leather,	McKean,	Allegheny River,	1
Ladlow,	J. G. Curtis,	McKean,	Tomesta Creek,	1
Mc. Jewett,	Mc. Jewett,	McKean,	Allegheny River,	1
Port Allegany,	Elk Tannery,	McKean,	Allegheny River,	1
Condersport,	Elk Tannery,	Potter,	Allegheny River,	1
Clarion,	Elk Tannery,	Warren,	Tomesta Creek,	1
Spring Creek,	Howard Tannery,	Warren,	Brokenshaw Creek,	1
Glades Run,	Howard Tannery,	Warren,	Brokenshaw Creek,	1
Stonham,	Elk Tannery,	Warren,	Allegheny River,	1
Sheffield,	Elk Tannery,	Warren,	Allegheny River,	1
In New York State.				
Limestone, .....	.....	Cattaraugus,	Tonawagant Creek,	1
Olean, .....	.....	Cattaraugus,	Allegheny River,	4
Portville, .....	.....	Cattaraugus,	Allegheny River,	1
Salamanca, .....	.....	Cattaraugus,	Allegheny River,	1
Total, .....	.....	.....	.....	27

TABLE XXVII.—List of Chemical Plants on Allegheny Basin.

Town.	Company	County.	Stream.	No. of Plants.
Roulette.	Gray Chemical.	Porter.	Allegheny River.	1
Liberty.	Liberty Chemical.	McKean.	Allegheny River.	1
Port Allegany.	Wyman Chemical.	McKean.	Allegheny River.	1
Port Allegany.	Gray Chemical.	McKean.	Allegheny River.	1
Corryville.	Corryville Chemical.	McKean.	Allegheny River.	2
Kusqueba.	National Chemical.	McKean.	Allegheny River.	2
Newton.	Newton Chemical.	McKean.	Kinzua Creek.	2
Mt. Alton.	Mt. Alton Chemical.	McKean.	Kinzua Creek.	1
Buttsville.	John Barkney Chemical.	McKean.	Kinzua Creek.	1
Bond Vein.	Alton Chemical.	McKean.	Kinzua Creek.	1
Kinzua.	Kinzua Chemical.	Warren.	Kinzua Creek.	1
Olivedale.	Olivedale Chemical.	McKean.	Kinzua Creek.	1
Morrison.	Himes Chemical.	McKean.	Kinzua Creek.	1
Westline.	E. F. Day Chemical.	McKean.	Kinzua Creek.	1
Struthers.	E. F. Smith & Co.	Warren.	Kinzua Creek.	1
Nearf.	Helmenann Chemical.	McKean.	Allegheny River.	1
St. Smithport.	Helmenann Chemical.	McKean.	Potato Creek.	1
Cransdale.	Marvindale Chemical.	McKean.	Potato Creek.	1
Cransdale.	Helmenann Chemical.	McKean.	Potato Creek.	1
Champion.	T. H. Quinn & Co.	McKean.	Potato Creek.	1
Conover.	Oswayo Chemical.	Potter.	Oswayo Creek.	1
Bradford.	A. B. Smith Chemical.	McKean.	Tunungawant Creek.	1
Bradford.	Nusbaum Chemical.	McKean.	Tunungawant Creek.	1
Custer City.	Custer City Chemical.	McKean.	Tunungawant Creek.	1
Degolia.	Minard Run Chemical.	McKean.	Tunungawant Creek.	1
Degolia.	American Acid & Alkali.	McKean.	Tunungawant Creek.	1
Taintor.	Taintor Chemical.	McKean.	Tunungawant Creek.	1
Lewis Run.	Lewis Run Manufacturing.	McKean.	Tunungawant Creek.	1
Wetmore.	Wetmore Chemical.	McKean.	Tunungawant Creek.	1
Roystone.	Koeler Chemical.	Warren.	Tionesta Creek.	1
Nauson.	Nauson Chemical.	Elk.	Tionesta Creek.	1
St. Marys.	M. J. Corbett Chemical.	Elk.	Elk Creek.	1
Dahoga.	McKean Chemical.	Elk.	Elk Creek.	1
Glen Hazel.	Wright Chemical.	Elk.	Clarion River.	1
Straight.	Starkawana Chemical.	Elk.	Clarion River.	1
Straight.	Straight Fiske Chemical.	Elk.	Clarion River.	1
Maxwell Run.	Clawson Fiske Chemical.	Jefferson.	Clarion River.	2
Spring Creek.	Pen Chemical.	Elk.	Bear Creek.	1
Truchline.	Pen Chemical.	McKean.	Clarion River.	1
Sprague.	Orto Chemical.	McKean.	Clarion River.	1
Bradford.	Bradford Chemical.	McKean.	Clarion River.	1
Monticutt.	Bradford Chemical.	McKean.	Clarion River.	1
Nant-y-ge.	Bradford Chemical.	Cambria.	Black Lick Creek.	1
In New York State.				
S. Vandalla.		Cattaraugus.	Allegheny River.	1
Red House.		Cattaraugus.	Allegheny River.	1
Total.				47

As stated before these plants manufacture charcoal, wood alcohol and acetate of lime. The only raw material employed is wood from deciduous trees, maple, beech, and birch being preferred. The trees are cut into lengths of three to four feet and air dried in piles either in the woods or in the wood yards of the factory. Without further treatment, these lengths of wood are placed in retorts which are built in pairs, each pair being heated by a single furnace. Each retort has its own condenser which is cooled with water drawn from the stream or pumped from wells in case the supply available from the stream is inadequate. The heating is continued for possibly eighteen to twenty hours; at the end of this time the wood is reduced to charcoal and tar, while the volatile matter and moisture have been condensed as pyroligneous acid. The charcoal is raked from the retorts into iron drums which are sealed with clay and allowed to cool; after cooling the charcoal is ready for the market. The pyroligneous acid goes first to the tar separators in which most of the tar is removed by settling while the "liquor" containing the alcohol and acetic acid together with the such impurities as acetone and other organic substances is run into the mixing tubs. In these tubs the liquor is mixed with milk of lime which fixes the acetic acid as calcium acetate, from which the wood alcohol may be separated by distillation. The contents of the mixing tubs are placed in stills, called the "coppers," and heat is applied until all the alcohol has been driven off and collected through the condenser. The liquid remaining in the still is a solution of acetate of lime and sludge of the salts and hydroxide of magnesium and other insoluble impurities introduced with the lime in the mixing tubs. The acetate of lime solution is run directly to evaporating pans and the sludge is placed in a box provided with some filtering material, such as burlap, and allowed to drain. It is then leached with warm water until practically all of the soluble matter in it has been removed. The liquid which drains out and that obtained from the leaching is added to that already in the evaporating pans and the whole evaporated to dryness. The residue so obtained, colored brown by the tar still present, is placed in sacks for sale as "brown acetate of lime." The material remaining after the leaching of the solid material from the "coppers" is a waste product and is either hauled out and dumped or else it is flushed into the sewer or drain.

The distillate from the lime stills consists of methyl alcohol, or wood naphtha, acetone and other impurities, with enough tar to give it a dark color. It is placed in the alcohol still and heated with a steam coil to a temperature but little above the boiling point of the alcohol. The first distillate from this still will run as high as eighty-nine per cent. alcohol. After the heating has been continued some time the receiver is changed and another portion collected, until the

distillate is too poor in alcohol to pay for further heating. This second portion may run as low as two per cent. alcohol. The distillates are sold as different grades of "crude alcohol." The residual liquor in the stills is called "alcohol water" and in every case is emptied into the sewer or drain.

The tar from the retorts and the tar from separators is placed in tar-stills and the moisture removed by heating. This increases the fuel value of the tar. The distillate from these stills is collected in tanks and separates into two layers. The upper layer is called "chemical oil" and is probably all creosote oil. The lower layer is weak acetic acid. The amount of this distillate is small and the tanks are allowed nearly a week to fill and settle. At the end of this time the bottom or watery layer is drawn off through a tap in the bottom and run into the mixing tub for treatment with lime and subsequent distillation as explained above. In the majority of the plants the "chemical oil" is run into the tar pit and fired under the boilers through a steam jet. The tar remaining in the still after the liquor and chemical oil have been removed is also run into the tar pit and used for fuel. In a few of the plants the chemical oil is collected and sold, bringing about ten cents a gallon.

From this brief description it will be seen that there are three main products of commercial value: charcoal, wood alcohol and acetate of lime. The amount of these procured from one cord of wood are—charcoal, forty to forty-five bushels; wood alcohol, nine to eleven gallons; acetate of lime, 200 pounds. In addition to these, tar and chemical oil possessing certain fuel value are produced and used at the plant. The waste products are the lime sludge and "alcohol water." Besides these there is one other form of pollution going into the stream and this is the water used about once a week for washing out the stills.

Section 2—Soil and Agriculture.

Forty-two per cent. of the basin is forest covered. The soil is generally poor. The country drained by the head waters of the Allegheny River lying in the northeastern section of the basin in western Potter and eastern McKean counties is not extensively devoted to farming. Most of the farm lands in this territory are found in the valley of Potato Creek and along the Allegheny immediately below the junction of Potato Creek. Practically the whole basin in New York State is well farmed except in the southern part where burnt over waste land abounds and in the vicinity of Chatauqua Lake where there are considerable areas of second growth timber. The

portion of Warren County bordering the Allegheny River and its tributaries is well adapted to farming and agriculture in the valley of the Brokenstraw and Conewango Creeks takes precedence over all other interests. Throughout the central portion of the Allegheny basin the soil is not as a rule utilized extensively for farming since the land is best adapted to grazing. In the southern part of the basin, however, the surface is capable of profitable cultivation and numerous well kept farms are found throughout this section.

In Bulletin No. 207 of the Twelfth Census the total acreage in farms in 1899, covering the entire area of nineteen counties all or part of which are in the Allegheny basin, is given as 6,308,025 and the improved acreage as 4,070,462. The following table based on that bulletin shows the percentage of improved areas to the total areas:

TABLE XXVIII.—Approximate Extent of Improved Land in the Allegheny Basin.

Counties.	Total area square miles.	Per cent. improved area of total.
Allegheny,	756	58.4
Armstrong,	614	66.2
Butler,	788	66.6
Cambria,	699	31.3
Clarion,	609	50.2
Clearfield,	1,155	22.6
Crawford,	1,056	55.5
Elk,	809	6.8
Erie,	808	55.4
Forest,	424	7.9
Indiana,	536	63.0
Jefferson,	661	38.9
McKean,	990	11.4
Mercer,	700	63.8
Potter,	1,078	18.0
Somerset,	1,038	42.1
Venango,	682	71.9
Warren,	910	22.6
Westmoreland,	1,063	58.4

The soil is a natural resource which is bound to receive scientific attention in the future when the economies of the time shall make it plain that this must be done.

Section 3.—Coal and Coke.

Bituminous coal is by far the most important mineral resource of the Allegheny basin. No anthracite coal is found within its borders. The great bituminous coal fields of Pennsylvania extend from the southwestern border of the State, northeasterly nearly to the New

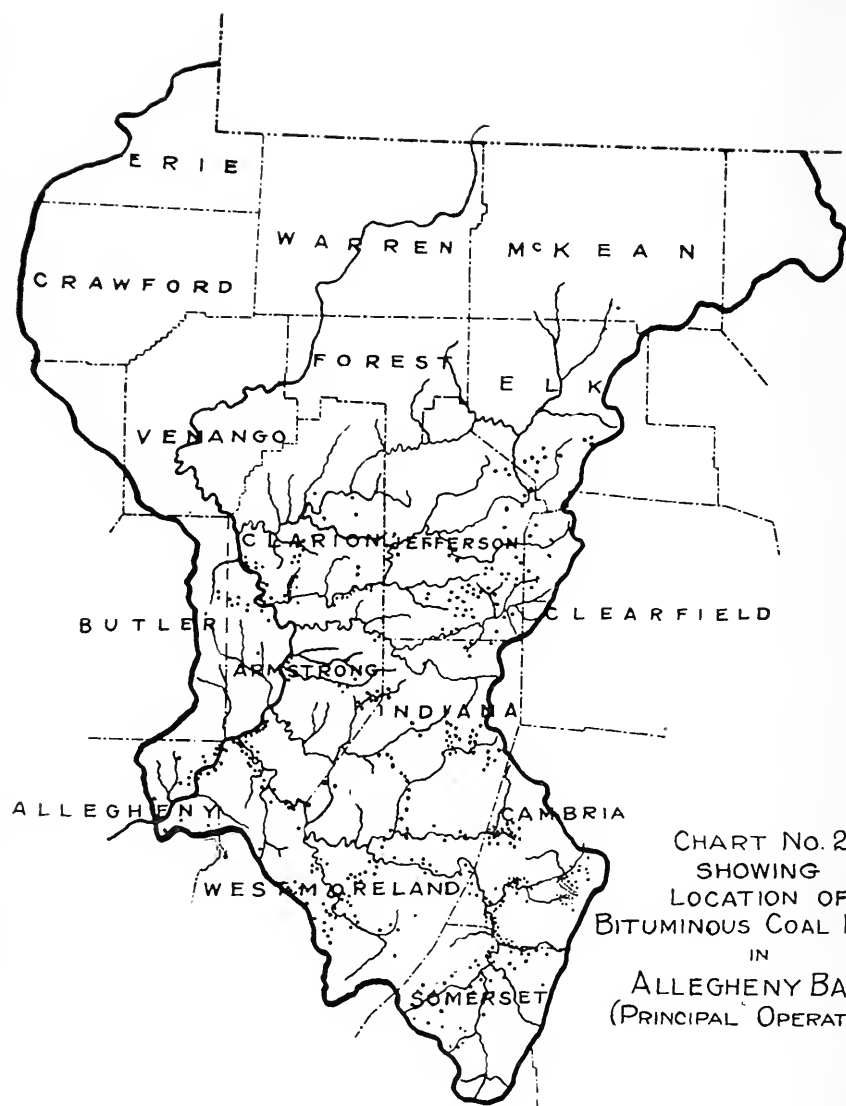


CHART No. 2
SHOWING
LOCATION OF
BITUMINOUS COAL MINES
IN
ALLEGHENY BASIN
(PRINCIPAL OPERATIONS)

York State line covering practically the entire western portion of Pennsylvania. The coal bearing rocks are found in every county represented in the basin except Erie County, although the coal found near the northern and northwestern margins consists mainly of scattering outcrops on the hill tops.

The upper Carboniferous series which produce all the bituminous coal are sub-divided, beginning with the lowest, into the following formations:

The Pottsville, or Conglomerate;

The Allegheny, or Lower Productive measures;

The Conemaugh, or Lower Barren measures;

And the Monongahela, or Upper Productive measures.

The Pottsville coal measures are the lowest in the series and are mined chiefly in the extensive outcrops near the margins of the fields. The Conemaugh yields little coal while the Allegheny and Monongahela formations produce about ninety-five per cent. of the output. Opportunities for further development are confined to the Allegheny formation, and mainly the lower and upper Kittanning and upper Freeport seams. With an increasing demand and exhaustion of some of the rich veins now being worked, it is probable that the Brookville and Clarion seams will be more extensively worked.

Table XXIX shows how great a tonnage of bituminous coal is produced in the Allegheny basin counties, compared with the production in Pennsylvania and the United States. The figures given for the Allegheny basin include the entire production of all the counties which lie wholly or partly in the basin and so they do not accurately represent the actual production within the basin.

TABLE XXIX.—Production of Bituminous Coal in Short Tons.

Year.	Allegheny Basin Counties.	Pennsyl- vania.	United States.
1890,	28,904,000	40,884,000	111,302,000
1891,	30,734,000	41,806,000	117,901,000
1892,	32,955,000	46,582,000	126,857,000
1893,	30,209,000	43,422,000	128,385,000
1894,	27,571,000	39,800,000	118,820,000
1895,	35,358,000	51,818,000	135,118,000
1896,	34,470,000	50,285,000	137,640,000
1897,	37,792,000	54,625,000	147,618,000
1898,	43,403,000	64,248,000	166,594,000
1899,	50,245,000	73,067,000	193,323,000
1900,	55,354,000	79,318,000	212,316,000
1901,	51,035,000	80,914,000	225,828,000
1902,	66,832,000	98,529,000	260,217,000
1903,	79,779,000	103,714,000	282,749,000
1904,	68,739,000	99,600,000	275,690,000
1905,	80,544,000	119,262,000	315,259,000
1906,	85,477,000	129,539,000	342,875,000
1907,	100,428,000	149,559,000	394,759,000
1908,	79,366,000	114,937,000	332,574,000
1909,	90,676,000	136,206,000	379,744,000
1910,	95,555,000	148,771,000	417,111,000

Allowance should be made for the large operations in the outlying portions of the border counties such as Clearfield, Cambria, Somerset, Allegheny and Westmoreland. In Table XXX is given the production for the year 1907 for all of the counties in the basin, sub-divided so as to show that of the hundred million tons produced in these counties for that year, 44,000,000 were mined wholly within the basin and 56,000,000 tons were mined in the border counties but outside the basin.

TABLE XXX.—Coal Production of Allegheny Basin by Counties for 1907 in Tons.

Counties—All or Part in Basin.	Total production of coal in these counties.	Production wholly within the basin.	Production wholly outside of basin.
Allegheny,	18,341,000	2,011,000	16,330,000
Armstrong,	2,565,000	2,565,000	.....
Butler,	932,000	66,000	866,000
Cambria,	16,088,000	8,851,000	7,234,000
Clarion,	1,060,000	1,060,000	.....
Clearfield,	7,954,000	1,550,000	6,404,000
Crawford, .....	.....	.....	.....
Elk,	1,435,000	875,000	620,000
Erie, .....	.....	.....	.....
Forest, .....	.....	.....	.....
Indiana,	7,591,000	4,941,000	2,650,000
Jefferson,	6,092,000	5,957,000	45,000
McKean,	6,000	6,000	.....
Monroe,	957,000	27,000	930,000
Potter, .....	.....	.....	.....
Somerset,	7,758,000	4,872,000	2,926,000
Venango, .....	.....	.....	.....
Warren, .....	.....	.....	.....
Westmoreland,	28,329,000	9,884,000	18,752,000
Total,	100,428,000	42,871,000	56,757,000

For the year 1907, the 44,000,000 tons of production were distributed by sub-drainage basins as follows:

	Tons.
Kelleyminas River Basin,	27,927,666
Mahoning Creek Basin,	4,223,000
Red Bank Creek Basin,	3,870,600
Clarion River Basin,	1,519,000
Crooked Creek Basin,	1,121,000
Remaining Main Basin along Allegheny River,	5,001,000
Total in Allegheny Basin,	43,671,600

The Department made an inspection at every coal mining operation on the basin. There are 724 mines distributed by sub-basins as follows:

384 in the Kiskiminetas water shed.

229 in the tributaries above—Clarion River,	58
Red Bank Creek, ..	77
Mahoning Creek, ...	74
Crooked Creek,	20

229

111 along Allegheny River.

724 in the Allegheny Basin.

A vast volume of acid mine drainage flows or is pumped from the mines. It totals 239 million gallons every 24 hours as follows:

144,500,000 gals. daily into Kiskiminetas River.

77,500,000 gals. daily into tributaries above—Clarion River,	15.8
Red Bank Creek, ..	24.0
Mahoning Creek, ..	32.4
Crooked Creek,	5.3

77.5

17,100,000 gals. daily along Allegheny River.

239,100,000 gals. daily in Allegheny Basin.

Seventy of these mines are operated by shaft. The others are drift or slope operations. The water has to be pumped from 136 mines; it flows by gravity out of 482 mines; and the balance discharge partly by gravity and partly by pumpage. This sulphurous water is the most potent pollution of all the industrial wastes emptied into the streams of the basin. The coal will not be exhausted for many generations. Hence the regulation of this pollution requires consideration.

In 1875, coke took precedence of anthracite coal, which in 1855 had taken the lead over charcoal in the manufacture of iron.

In the production of coke, the Allegheny Basin operations are important. In the year 1880, in the basin there were 1,165 ovens producing 385,000 tons of coke. In 1905, there were 7,354 ovens in the basin producing 2,500,000 tons of coke, which was one-eighth of the coke produced in Pennsylvania and one-thirteenth of the entire production of the United States. Practically all of the coke comes from the Cambria, Jefferson and Westmoreland districts.

In Table XXXI some data are given showing the extent of this industry:

TABLE XXXI.—Coke Production of the Allegheny Basin.

Year.	Ovens.	Short Tons.		Total Value of Coke at Ovens.
		Coal Used.	Coke Produced.	
1880,	1,165	566,000	375,000	\$731,231
1890,	4,565	2,176,000	1,386,000	2,510,146
1890,	5,350	3,035,000	1,873,000	3,986,939
1901,	5,570	2,776,000	1,707,000	3,318,551
1902,	6,509	3,631,000	2,271,000	5,398,135
1903,	6,986	3,718,000	2,331,000	6,961,554
1904,	7,241	2,639,000	1,652,000	3,228,148
1905,	7,354	4,029,000	2,555,000	5,506,391

Entire State of Pennsylvania

Year.	Ovens.	Short Tons.		Total Value of Coke at Ovens.
		Coal Used.	Coke Produced.	
1905,	44,992	31,030,000	20,574,000	\$42,253,178

The Entire United States

Year.	Ovens.	Short Tons.		Total Value of Coke at Ovens.
		Coal Used.	Coke Produced.	
1905,	92,315	49,731,000	32,231,000	\$72,476,196

At some of the coking operations the coal is washed before it is coked and the dirty water goes to the streams which it highly discolors

The coal dirt and dust is transported during times of freshets even to the mouth of the Allegheny River. This pollution adds to the problem of preserving the purity of the waters in the basin, as will hereafter appear.

Section 4.—Iron Ore and Steel Manufacture.

Iron ore occurs in scattered deposits throughout the Allegheny basin. It is mostly fossil ore and carbonate ore of low grade. The best deposits are not uniform in quality nor extensive. Before the introduction of anthracite coal and of coke in the manufacture of iron, the abundance of timber led to the erection of charcoal furnaces near outcrops of the better grades of ore; but the operations were largely local because of the high cost of transportation of the manufactured product and the uncertainty as to the quality and extent of the ore deposits.

The ores of the Pottsville formation are of little value. The Allegheny fossil ores, associated with the limestones, and the Conemaugh carbonate ores formed the chief sources of supply.

During the first half of the last century a large number of furnaces were built in the Allegheny basin, mainly in the Ligonier Valley, Westmoreland County, and along the Allegheny and its tributaries in Armstrong, Clarion, and Indiana Counties. Local operations of minor importance were carried on for a time in Allegheny, Butler, Crawford, Mercer, Venango, Erie, and Somerset Counties.

The first furnace for the production of iron west of the Allegheny Mountains was known as the "Westmoreland Furnace". It was started up in 1794 in the Ligonier Valley on Furnace Run near Loyalhanna Creek. The first furnace in Somerset County was started in 1807, in Armstrong County in 1818, in Clarion County in 1828, in Venango County in 1830, in Indiana County in 1840, and in Erie and Cambria Counties in 1842. Extensive furnaces at Brady's Bend were started in 1840 and closed in 1873. The iron from these various furnaces, that was not used locally, was taken by pack-horses or wagons to the nearest navigable stream and thence by keel-boat or "arks" down the Youghiogheny or the Allegheny and tributaries to Pittsburgh.

Improved methods were developed in the manufacture of iron, timber in the immediate vicinity of the furnaces became exhausted and everything conspired to bring about an abandonment of the furnaces. The famous Johnstown ore bed, a local but extensive deposit of high grade ore was closed in 1873. This deposit was the chief source of supply for the Cambria Iron Company, at Johnstown. The furnaces there were started in 1853. A Bessemer furnace plant was first started on July 10th, 1871, and resulted in the closing of the Johnstown ore mines two years later.

The industry is the most important one in Pennsylvania. The ores are now imported; but the coal and the coke and the limestone and the skilled labor are local. The industry is a permanent one together with its allied manufactures. So important has the water supply become to these industries, that the purity of the streams demands consideration from an economic point of view. Extensive water softening plants may now be found at all of the important iron and steel mills in the basin.

The modern furnaces and iron and steel mills use enormous quantities of water. From the plants, spent acid, pickling liquors, sewage and other wastes are discharged into the streams and pollute the waters. At some of the mills it is profitable to reclaim certain by-products that were formerly wasted to the stream.

Section 5.—Petroleum and Natural Gas.

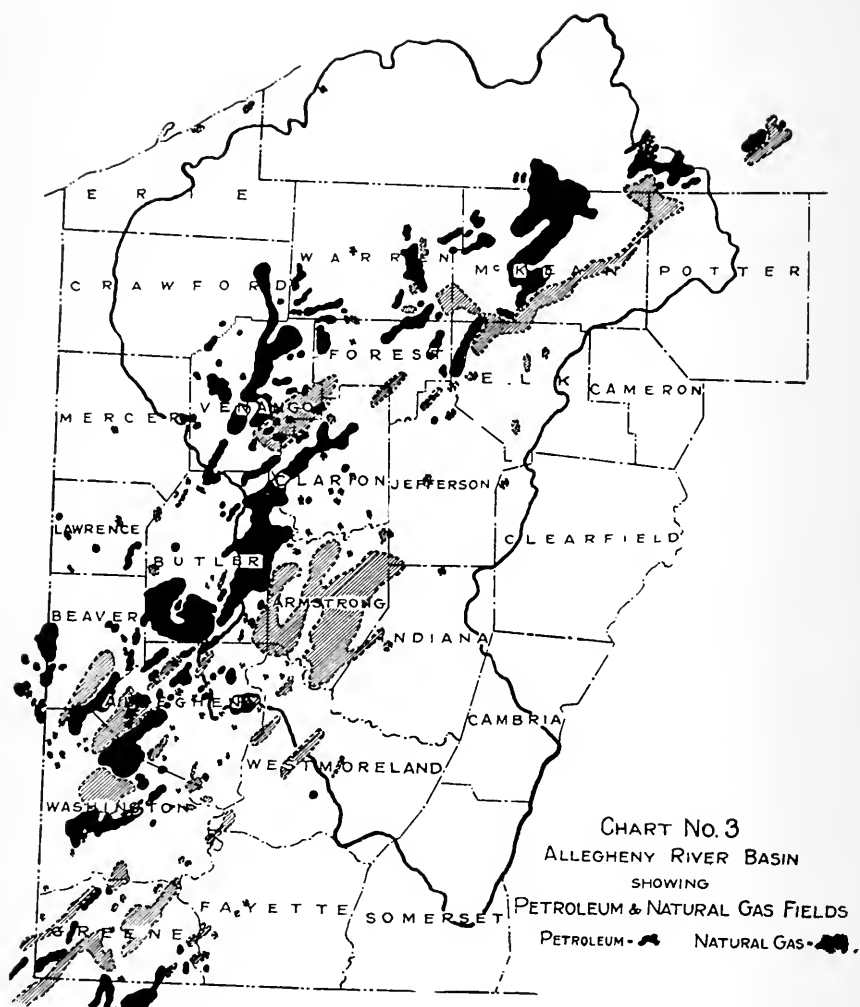
Petroleum in America was known and valued for its medicinal properties from very early times as is evidenced from the finding by the earliest settlers of many large pits in the vicinity of Oil Creek, Venango County, frequently log lined, in which oil was collected. The Indians used this oil extensively as a remedy, attributing the pits to an earlier race of higher civilization, presumably contemporaneous with the Mound Builders and Copper Miners of Lake Superior.

Beginning with the first drilled well in 1806, many wells were put down in Kentucky and West Virginia for salt brine. These also frequently yielded quantities of petroleum which was considered a nuisance and allowed to run to waste. In 1829, one of these Kentucky wells struck pure oil flowing intermittently at periods of a few minutes which was later bottled and sold in some quantities previous to 1860, as "The American Medicinal Oil."

As early as 1833, Doctor S. P. Hildreth, pointed out the value of the oil obtained from the salt wells along the Kanawha as an illuminant and lubricant. Little attention was paid to its possibilities until about 1855, when S. M. Kier sold the oil from salt wells at Tarentum as a panacea for all ills and began refining it as an illuminant.

The petroleum industry of this country may be said to have had its origin in Venango County near the mouth of Oil Creek, a tributary of the Allegheny River, in 1855. At that time operations were begun on a small scale to obtain oil from surface workings by skimming off the oil floating on the water near the oil springs in that neighborhood. With a view of obtaining the oil in larger quantities, the first well drilled for this purpose in the country and probably in the world, was put down near Titusville in 1859. Oil was struck at a depth of sixty-nine feet yielding to the pump about twenty-five barrels daily. The fame of this so-called "Drake Well" led immediately to the sinking of others and the industry developed rapidly until the Oil Creek neighborhood became a scene of wild excitement. Speculation ran riot and enormous fortunes were made and frequently lost. The success of the Oil Creek field was followed by the location of new fields in various parts of the Upper Allegheny Basin. From 25 barrels daily in August, 1859, production increased to 15,000 barrels a day in 1862. The effect of this enormous output was to bring the price so low that in May, 1865, the production had been reduced to about 4,000 barrels daily. Probably 10,000,000 barrels of oil ran to waste on this account.

Oil City was the centre of the petroleum industry at this time. Production in the Allegheny Basin increased with the growth of the market until 1882, when it reached its maximum, approximately



70 per cent. of the output of the entire country. After this there was a decrease in production. In 1896, owing to the development of fields outside of the Allegheny Basin, the production was less than one-quarter of the total for the United States and about two-thirds of that for Pennsylvania. Science or experience has demonstrated no definite way of estimating the extent of oil and gas resources. Much of the area in the Allegheny Basin is entirely depleted. Parts of the older section have been reduced from an output of many hundreds of barrels a well each day to about two or three barrels; and many wells have been abandoned.

Oil is mainly found in the anticlines or pockets formed by the folded strata where it has collected, usually in the porous sandstones which are overlaid by more impervious formations. It is often found associated with salt water and gas with the heavier water below and the lighter gas above.

The Allegheny River surface is streaked with oil. The oil collects around the wells and tanks on the watershed. Some escapes at refineries. The injurious effect of this pollution is very pronounced even as far as Pittsburgh as will be shown later.

The decline in oil production has been felt at Bradford, Warren, Titusville, Oil City, Franklin, Parker and at other places in the Allegheny Basin. Bradford is recovering. New enterprises are being secured. This city is a centre for the chemical industry of the Upper Basin. Franklin City has the largest refinery in the world. From crude oil come hundreds of by-products. There is one by-product which forms naturally on the ground at the wells and around tanks where oil escapes. It is paraffine. Paraffine is also found on the rocks and shores of the streams in the oil fields. In time it washes off and floats down to Pittsburgh where it interferes with the operation of the city filters at Aspinwall.

The natural gas fields are closely related to the oil fields. The known productive areas are quite extensive in Venango, Armstrong, Clarion and Westmoreland counties, with many small fields scattered generally throughout the basin. Extensive use of natural gas for commercial purposes was begun about 1883, although for some years it had been used locally as fuel. Many of the oil wells produce sufficient gas for their own pumping. Back in 1864, gas was struck in a well drilled for oil at Weikel Run. The well was plugged and abandoned. This was the practice for many years until the commercial value of gas was realized. Then it was thought that the supply was inexhaustible which led to enormous waste of it. The producers sold the gas at a flat rate and at extremely low prices. There was no incentive to save this natural product. The value of the output in Pennsylvania was \$75,000 in 1882. In 1888, it was \$19,000,000. The value then dropped to \$11,000,000 in 1889, and then to \$5,000,000

in 1896. Thereafter there was a steady rise in value until the \$19,000,000 mark was passed in 1905. The actual volume of gas has probably diminished since the price has greatly advanced and compulsory use of meters has prevented the former enormous waste. Natural gas is now chiefly used for domestic purposes. The greater part of the gas produced in Pennsylvania at present comes from the southern fields. Extensive explorations give little hope of replenishing the rapidly diminishing output from the Allegheny Basin; but at the coke ovens great volumes of gas are wasted every day as a by-product. Undoubtedly this economic crime will be corrected. At some of the gas wells there is a flow of salt water which mingles with the naturally pure waters of the streams and renders them unfit for domestic uses below. This matter needs to be most carefully watched. There is no way of economically removing objectionable quantities of saline ingredients from water, once these ingredients have been permitted to characterize the water. The remedy is one of prevention in the first place.

Section 6.—Clay and Clay Products.

The clay deposits of the Allegheny Basin are of great value. Pennsylvania leads in the production of fire brick. In the total value of clay products it is second only to Ohio. Nearly one-half of the fire brick produced in the United States comes from Pennsylvania. Clays and shales, making this possible, are found widely distributed throughout the basin, mainly south of the terminal moraine. They belong to the Devonian and Carboniferous systems, though the former is little used. The clays used in the manufacture of common brick, pressed brick and terra cotta, are derived mainly from the decomposed carboniferous shales. The stoneware clays are found in the lower coal measures, especially those underlying the Lower Kittanning. The fire clays are found in the basin generally underlying the coal seams of the Pottsville and Allegheny formations. Of the Pottsville, the Alton clay is found in Elk County; the Mercer (possibly the same as the Alton) in Butler and Mercer Counties; and the Sharon in Elk and Mercer Counties. The Allegheny series yields five clays of economic importance; the Brookville, found in Clearfield, Elk, and Jefferson Counties; the Clarion, found in Indiana County; the Ferriferous, found in Armstrong County; the Kittanning, found in Armstrong and Westmoreland Counties; and the Upper Freeport, or Bolivar clay, found in Allegheny, Armstrong, Butler, Indiana, Somerset, and Westmoreland counties. The last is very extensively mined, especially in the vicinity of Bolivar, Indiana County.

Large plants for the manufacture of clay products are located at the following places:

TABLE XXXII.—Large Plants for the Manufacture of Clay Products.

FIRE BRICK.		
1 Black Lick.	7 Johnsonburg.	13 Mineral Point.
2 Barking.	8 Kingston.	14 St. Charles Station.
3 Bolivar.	9 Kittanning.	15 Salina.
4 Cowanshannock.	10 Lockport.	16 South Fork.
5 Climax.	11 Manorville.	17 Silgo.
6 Johnstown.	12 Monmouth.	18 Tylersburg.
PAVING BRICK.		
1 New Kensington.	4 Hyde Park.	7 Falls Creek.
2 Black Lick.	5 Ridgeway.	8 Bolivar.
3 Kittanning.	6 Johnsonburg.	9 Johnstown.
POTTERY BRICK.		
1 Ford City.	3 Kittanning.	4 New Bethlehem.
2 Hawthorne.		5 Girty.
BUILDING BRICK.		
1 Ford City.	4 Black Lick.	7 Sheridan.
2 Kittanning.	5 Blairsville.	8 Johnstown.
3 Ligonier.	6 Blairsville Int.	9 Hyde Park.
TERRA COTTA TILE AND PIPE.		
1 Kittanning.	2 Johnetta.	3 St. Marys.

These works do not especially contribute to stream pollution; but they mean a substantial community from which sewage is discharged into State waters.

Section 7.—Miscellaneous Minerals and Products.

The fossiliferous limestone is the most extensive outcrop in the Clarion River section, covering a broad central belt averaging eight feet thick. The Freeport upper limestone is high in lime and low in phosphorous and is said to be the best flux in the region. It is used at the Kittanning furnaces.

A fair quality of sandstone for building purposes is found in the basin. There are extensive quarries at Cowanshannock, Templeton, Freeport, and on the river above Oil City.

Glass sand rock is found notably at Kennerdell. Deposits are also found elsewhere but they are not extensive. The manufacture of glass is an important industry in the region. There are twelve works along the main stream and fourteen on the tributaries making twenty-six in the Allegheny Basin. Some local sand is used but most of it is shipped in from parts of Pennsylvania east of the Allegheny Ridge.

During the first half of the last century salt was an important industry along the Lower Allegheny River and Kiskiminetas. There are extensive deposits of rock salt which yield abundant salt water. As cheaper methods of production were developed outside of Pennsylvania, this industry declined.

Large mineral springs found in the northern part of the basin especially in Crawford and Venango Counties, have led to the establishment of summer resorts and sanatoria. The waters are extensively bottled. Among the more important of these springs may be mentioned those at Cambridge Springs and at Saegertown, Crawford County.

The utilization of these mineral resources has materially advanced the prosperity of the inhabitants. It has aided in the maintenance and growth of communities and it has been accompanied by the sewage pollution of the streams draining the localities occupied by them. There is a minor pollution even at some of the best plants due to the discharge of scumming waters and spent liquors.

Section 8.—Water Supply, Power, and Transportation.

The water resources of the Allegheny Basin are tremendous in possibilities. Elsewhere in the report will be found detailed mention of the uses of the streams for water supply, power, and transportation. There are at present several very large hydro-electric power development projects under consideration by private capitalists. If the water resources of the entire basin were to be studied as a whole and a system for their perfect development were mapped out in a comprehensive manner and then followed as time went on, the waters could be put to their various uses to the best advantage and for the greatest benefit to the inhabitants. Such a procedure would demand a study by the State and the adoption of a policy of control. At present very little has been done in the way of developing water power. There are seventy-four small water power plants on the basin now. Three of them are in New York State.

In the early development of Pittsburgh, the transportation afforded by the natural waterways was of great importance. The first steam boat on the western rivers was built at Pittsburgh in 1811. As previously stated, the Allegheny River has been improved by the Federal Government with a system of locks and dams which maintain slack water at a depth of eight feet twenty-four miles up stream to Natrona. Above Natrona the river is navigable for shallow boats. At shoals, the Government has built dykes to improve the depth. The Allegheny has been navigated by a steam boat as far as Olean,

254 miles above the mouth; but the river traffic has never been active above Kittanning in recent years. Navigation cannot be accomplished at usual low water. The floating of boats is not attempted at a stage less than eighteen inches over riffles and is usually done at favorable spring and autumn stages of about four feet at Franklin to ten feet at Pittsburgh.

The importance of water transportation to the new western country a century ago, led to an early development of waterways. In 1834, the Pennsylvania Canal was built across the State from east to west connecting tide water with Pittsburgh. The Canal passed up the Juniata Valley westward to Holidaysburg. Here the boats were transferred to carriages that passed over the mountains on a system of inclined planes to Johnstown, whence the Canal continued to Pittsburgh via the Conemaugh and Kiskiminetas and Allegheny Rivers. Improvements in water transportation were made along French Creek and the upper Allegheny River; but these were all abandoned thirty or forty years ago to make way for the steam railroad. Ultimately waterway transportation may again return with the development of water power and be an asset of the Allegheny Basin.

With the impounding of enormous quantities of water will come a change and improvement in the quality of the water. There will be less turbidity and more dilution and consequently less hardness and acidity and greater potability and purity of water. Fish life ought also to be more abundant.

Section 9.—Fish as Food.

Before the waters of the Allegheny Basin were polluted by industrial waste and by sewage, fish were abundant in the streams and they furnished a staple article of food for man. Now in many of the streams fish life is extinct because of the pollutions. Thousands of them perish at a time and float down the river. Sometimes they strand, decompose and produce a nuisance that is the subject of complaint to the health authorities. Water that is not fit for fish to live in may not be considered enticing as a source of supply for towns. It is important that the streams should be stocked and that the waters of these stocked streams should be at least pure enough to support fish life. The Commonwealth maintains a Department of Fisheries and laws are being administered whose object is to restore to the streams normal aquatic life.

The streams of the Allegheny Basin that are not too grossly polluted were stocked by the State Department of Fisheries with various kinds of food and game fish. During 1908 six per cent. of the total output

of the eight State Hatcheries was placed in these waters. This stocking comprised 2.5 million trout, 14 million yellow perch, 9.5 million pike perch, 13 million pickerel, besides 480,000 fish of other varieties.

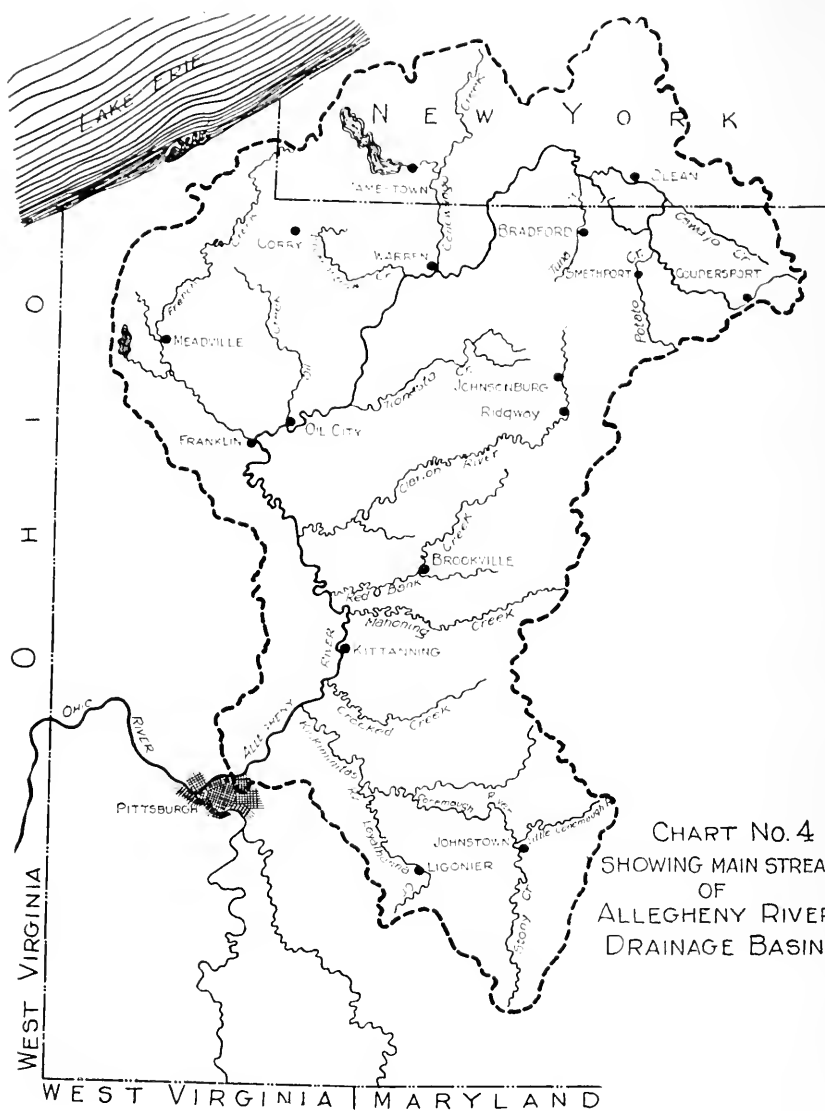
Section 10.—Railroads.

In the development of the natural resources and in supplanting waterway transportation, a net work of steam railroads has been built which reaches within ten miles of every point within the Allegheny Basin and there are very few points indeed ten miles remote from such transportation. The Allegheny River itself is followed by railroads throughout its length and the same is substantially true of all its main tributaries. Two exceptions might be made, namely Mahoning and Crooked Creeks. However, railroads traverse a large portion of the length of both these streams, but leave the watershed some distance above their confluence with the Allegheny.

There are twelve railroad systems represented in the Basin totalling a mileage of 2,259. One system has twelve miles only in the Basin. The Pennsylvania Railroad System is the largest, having 1,048 miles in the Basin.

There are seventeen independent railroad companies in the Basin ranging in length from one to eighty-five miles and aggregating a total mileage of 276. So there are 2,535 miles of steam railroads operated in the Allegheny Basin.

Applying average figures for the entire State to the mileage within the Basin, it will appear that there are approximately 7,000 passengers and employees constantly travelling on the trains in the Basin. There are also about 400 employees continuously at work along the tracks. It is manifestly impossible even to estimate the degree of danger to public health which results from the sewage pollution of the streams draining the roadbeds of the railroads. The pollutions from passenger coaches passing over an upland and uninhabited watershed, the waters of which are used as a source of drinking water in a town near by, are believed to have caused at least one typhoid epidemic. It is evident that where the streams are polluted with the sewage of communities, this additional pollution is relatively not important but it is evident that on uninhabited watersheds where the streams flow swiftly and quickly carrying any pollutions entering them to the water consumers in the town, the menace is no negligible matter and that the hazard to public health should be lessened.



PART IV

THE SURVEY IN DETAIL.

This part of the report deals with the survey in detail. The Allegheny Basin is divided into fifteen sections for convenience. Each sub-division is treated separately and described in consecutive order from the source to Pittsburgh. The points of division are Potato Creek; Oswayo Creek, Tunungawant Creek, New York-Pennsylvania State Line, Conewango Creek, Brokenstraw Creek, Tionesta Creek, Oil Creek, French Creek, Clarion River, Red Bank Creek, Mahoning Creek, Crooked Creek, Kiskiminetas River, and the City of Pittsburgh.

In each section the physical characteristics, natural resources and their developments, the population, towns—their situation, industries, water supply, sewerage and health—purity of the streams and the polluting factors are described. In this part the population figures are as estimated in 1909, except in cases where the Federal census of 1910 is noted.

Section 1.—Source to Potato Creek.

The Allegheny River rises in the high, hilly plateau region in the northeastern part of the basin at an elevation of 2,250 feet above sea level. From its source in central Potter County, Pennsylvania, the Allegheny flows in a general southwesterly direction to below Coudersport, where in a long bend it turns to the northwest and follows this direction, in a meandering course to the eastern part of McKean County, where it is joined by Potato Creek.

The extreme headwaters of the river flow between low banks; the valley often extending a mile on each side to the foot hills being partly covered with a good second growth of hard woods. For about ten miles on either side of Coudersport the valley is partly farmed, but for the most part is covered with decaying logs, evidence of the wasteful methods employed in early tan bark operations. Above Port Allegany the river flows through a broad valley with flat, partly farmed bottom lands, many of the farms extending up the hillsides. Near Sartwell, McKean County, there are extensive groups of gas

wells. The steepest slopes throughout the length of the river occur in this section, being about twenty-seven feet to the mile, during the first thirty miles. The area of this division of the watershed is about 309 square miles with a population of 16,070—urban 8,390—rural 7,680—giving a total population of fifty-four to the square mile.

In the river above Potato Creek are found both trout and pike to a considerable extent while in all the tributary streams trout are plentiful, being native to these waters and increasing rapidly. The natural conditions are especially favorable, this being one of the best trout districts in Pennsylvania. The number of fish found in these waters has been materially increased by re-stocking from the State fish hatcheries. Exception must be made of those portions of the branches of the main stream which receive the wastes from chemical plants, tanneries, and saw mills. The chemical plant wastes, as well as the tannery wastes, destroy fish for many miles down stream and from Coudersport down there are a number of sawmills which discharge quantities of sawdust into the stream, which at times of low water injures and drives out many of the fish. During times of high water the wastes from these sources are so diluted that the fish come up stream even to close proximity to the plants, remain in the pools as the water recedes and with increasing concentration of the wastes, as the water becomes lower, are frequently destroyed in large numbers.

So far as the Department is informed, there are but two water power installations on the streams of this section both of which are on the river at Coudersport and are of minor importance.

The chief industries are the tanneries, glass plants, chemical plants, saw mills, and other wood working plants. This section, especially the lower part near the mouth of Potato Creek, yields natural gas in considerable though diminishing quantities. The decreasing supply of gas here as well as throughout the upper portion of the Allegheny Basin, is seriously affecting the operation of the numerous glass plants of which there are several at Coudersport and Port Allegany.

Formerly this section was covered with a thick growth of forest and its development centred around the lumber industry. At present there is little if any virgin timber remaining, although well advanced, second growth timber forms a valuable asset and supports a number of sawmills and other wood working establishments.

The Buffalo Division of the Pennsylvania Railroad follows the river up as far as Port Allegany and thence along its south fork to the head waters of the branch. From Port Allegany to the head waters, the Coudersport and Port Allegany Railroad follows closely the main

stream with a branch line extending from Coudersport a few miles up one of the tributaries. The total mileage of these railroads is about fifty-one miles.

In addition to the sewage pollution of a population estimated at 8,760—rural 770, urban 7,990,—this portion of the river receives manufacturing wastes from the following industrial plants: The Elk Tanning Company's tannery at Coudersport and the same company's tannery at Port Allegany. These are the only tanneries in this section. It is reported that cattle belonging to riparian owners below Port Allegany have been seriously affected by drinking the water of the river, and it is claimed that some of them have died of anthrax, attributed to tannery wastes.

The wastes from chemical plants have already been referred to. There are five of these plants in this section, namely the Liberty Chemical Products Company of Liberty, the Gray Chemical Company at Roulette, the Wyman Chemical Company of Port Allegany, and two plants of the Gray Chemical Company at Port Allegany. The last named company reports that they are now utilizing the wastes from their plants at Port Allegany and Roulette—tar and oil as fuel and the waste from the lime stills as fertilizer.

So far as has been ascertained, there is but one industrial water supply system in this territory—that of the Elk Tanning Company at Port Allegany where water for industrial purposes is drawn from the Allegheny River. For domestic consumption, Coudersport is supplied from mountain streams, Roulette from springs and Lanegar Creek, Mina from a spring and Port Allegany from mountain springs and streams.

Coudersport is the county seat of Potter County and is an incorporated borough with an estimated population of 3,690. It has grown rapidly in the past but there is no indication that there will be a marked increase in the near future. It is a manufacturing town, its principal industries comprising the tannery of the Elk Tanning Company, employing about 300 men, a small condensed milk factory and several small plants for the manufacture of baskets, barrels and clothes pins. A water company supplies about eighty-six per cent. of the population with water from mountain streams. The manufactural wastes contributed to the river from Coudersport consist of the wastes discharged from an eight-inch sewer from the condensed milk factory and the wastes from the tannery, a serious pollution. The borough has about three miles of public, combined sewers serving about 1,500 persons and eighty private sewers serving about the same number, as well as some 3,000 feet of storm sewers. The river above Coudersport is generally clear and of good appearance, but after passing the borough there is a marked change, due to the presence of sewage and manufactural wastes.

Mina, a small, unincorporated village on the Allegheny River a short distance below Coudersport with a population of about 250 is dependent industrially upon a saw mill and lumber yard. It has a public water supply consisting of spigots and hydrants placed at intervals along the curb to which water is piped from a spring.

Roulette, Potter County, is an unincorporated village with several industries, including a stove and heading factory, a chemical plant of the Gray Chemical Company, a lumber mill, and, until recently, a glass works. The latter plant was recently burned and as a result, the population has been reduced from 1,200 to about 800. Some 400 persons are supplied with water by the Roulette Water Company a corporation deriving its supply mainly from springs, with two reservoirs of 40,000 and 190,000 gallons capacity. The company also has an emergency intake on Lanegar Creek about 1.5 miles above its confluence with the Allegheny. The timber in the locality is becoming rapidly exhausted. There is no public sewerage system and only three small private sewers discharge into the river. There are fifteen cesspools and 221 earth privy vaults. A decree was issued to the Roulette Water Company on November 23rd, 1908, approving, under certain conditions, the enlargement of its reservoirs and requiring that the public be notified to boil all water at such times as it may be necessary to use the Lanegar Creek supply.

Port Allegany, an incorporated borough with a population of 3,500, is an industrial town with three glass companies (The Allegheny Window Glass Company with 250 employees, the Mississippi Window Glass Company with 125 employees, and the Olean Glass Company with 100 employees), a tannery of the Elk Tanning Company employing 120 men and turning out 500 skins a day, and bark extract works of the American Extract Company with about twenty employees. Water is supplied to this community by a private corporation and is taken from mountain springs and streams, the watershed of which is uninhabited. There are three reservoirs with a combined capacity of 595,000 gallons beside an emergency reservoir with a capacity of 800,000 gallons for fire purposes. Nearly all of the inhabitants use this supply. The borough has a comprehensive, public system of sanitary sewers discharging into the river through one eighteen-inch outlet and serving about nine-tenths of the population. In addition, there are several private sewers so that the total population probably contributes sewage to the stream. The manufactural wastes come almost entirely from the tannery and are quite extensive.

On February 8, 1912, the Commissioner of Health issued a decree relative to sewerage to the borough of Port Allegany approving certain sewer extensions, subject to the following conditions and stipulations:

"*First:* The borough shall on or before July 1st, 1912, place on file in the office of the Department of Health, in addition to the plans already filed, profiles of its existing sewers. This data shall be sufficiently in detail to supply the Department of Health with all necessary information respecting the borough sewer system, which information, as respects grades, is now lacking.

"*Second:* On or before July first, 1912, the borough shall prepare and submit to the Commissioner of Health for approval, plans for the collection and disposal of all of the sewage of Port Allegany. These plans shall be accompanied by a report and estimates of cost of construction of a sewage disposal plant and necessary outfall sewer to reach it.

"*Third:* This permit to discharge sewage into the waters of the State shall cease on the first day of July, 1912, but if on this date the terms of this permit have been complied with, then the Commissioner of Health shall extend the time in which sewage may continue to be discharged into State Waters, the intent being that the discontinuance of the discharge of sewage and industrial wastes into State waters shall be brought about at as early a date as practicable.

"*Fourth:* In the preparation of the plans for the comprehensive sewerage system and sewage disposal works, the matter of taking in the industrial wastes and of treating them in the same plant with the domestic sewage shall be given careful consideration. It will probably prove advantageous to the municipality to adopt this plan.

"The especial attention of the local authorities is directed to the necessity of the overhanging privies being abandoned and of the collection and treatment of the industrial as well as domestic sewage of the town. A communication will be addressed to each of the industrial corporations in Port Allegany advising co-operation between the owners and the municipal authorities in the designing of a comprehensive system of sewerage and sewage disposal works. The Penn Tanning Company, operated by the Elk Tanning Company, The American Extract Company and the Allegheny Window Glass Company will receive such communications."

Typhoid fever cases have been reported to the State Department of Health by the local authorities of the boroughs of Port Allegany and Coudersport as shown in the following table:

Typhoid Fever Cases Reported for the Section of the Allegheny Basin from the Source of the River to Potato Creek, 1906-1912, inclusive.

Town.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
Port Allegany,	0	0	5	0	0	0	1
Coudersport,	5	4	4	4	1	4	2

Section 2.—Potato Creek to Oswayo Creek.

(a) *Along the Allegheny River.* After its junction with Potato Creek, the Allegheny River flows in a northerly direction for about six miles where it makes a short turn to the east and follows this direction for about three miles. It then turns to the north and enters New York State in the extreme southeastern corner of Cattaraugus County. Here enters Oswayo Creek, the first tributary to the Allegheny in New York State. During this part of its course the river flows through a flat valley and its slope is less than two feet in a mile.

This is singular, being less than the rate of fall for the greater portion of the river. Parts of this valley are marshy, but for the most part the flat lands, as well as the side hills on either side are fairly well cultivated. A small branch which enters the river immediately below Potato Creek is stained black by wastes from a chemical plant at Corryville. The total population on the watershed between Potato Creek and Oswayo Creek is 5,400, divided as follows: urban 1,800, rural 3,600. Eldred, with a population of 1,800, the only town on this portion of the river, has a tannery which discharges its wastes into the stream. The area of this portion of the watershed is about eight-two square miles, giving a total population of sixty-six to the square mile.

A chemical plant at Corryville, a tannery, and two glass plants at Eldred and a powder factory at Bullis Mills are the most important industries.

There are about fourteen miles of railroads traversing this section, consisting of the Buffalo and Chautauqua Divisions of the Pennsylvania Railroad, which follow this portion of the river practically throughout. At State Line Junction a branch of the Pittsburgh, Shawmut and Northern Railroad barely enters this territory.

This portion of the river is not used for power or navigation purposes, nor as a source of domestic water supply. The only public domestic supply in the section is at Eldred and is derived from the headwaters of Barden Brook. The Eldred Leather Company at Eldred derives an industrial supply from the river and reports that the water has a deleterious effect on their steam piping.

Some trout and pike are found, the conditions being similar to those found in Section 1. The chemical plant and tannery add to the pollution. The upper waters of the small branches are good trout streams, trout having been used almost exclusively by the State Fish Commission in stocking the streams.

There is but one sewer system, that of Eldred, which contributes the sewage from about 430 persons. Industrial wastes are contributed by the Corryville Chemical Company, a wood alcohol plant. The Kervin Glass Company and the Eldred Window Glass Company at Eldred, both contribute acid wastes. The Eldred Leather Company discharges tannery wastes to the river.

Eldred Borough, the only important municipality, has an estimated population of 1,800. Water is supplied to the public by a private corporation serving approximately 1,600 consumers, the remainder of the population depending upon wells and springs. The daily average consumption is approximately 150,000 gallons of water, all of which passes through one or the other of two reservoirs, capacities of 160,000 gallons and 225,000 gallons. These reservoirs are located at the headwaters of Barden Brook, a small tributary of the river. The

greater portion of the population is without sewerage facilities. Bath and kitchen wastes are discharged indiscriminately into the street gutters and privies are in general use. There is one combined public sewer with a fifteen-inch outlet to which a few properties are connected, and it is estimated that the sewage of approximately 430 inhabitants of the borough is discharged into the river. The industries comprise two glass plants, a tannery, cutlery works and a wood working plant. The Eldred Leather Company handles green salt hides, using both extract and bark, and lime for de-hairing. The liquid wastes are slightly colored by the spent tanning liquors and probably amount to about 10,000 gallons a day. The Kervin Glass Company has a twelve-inch sewer receiving the sewage of its 150 employees as well as considerable muriatic acid. The Eldred Window Glass Company has a six-inch sewer which similarly serves 125 men and receives muriatic acid wastes, and cooling water.

(b) *Potato Creek Drainage Area.* Potato Creek, the largest affluent of the Upper Allegheny River before it leaves the State of Pennsylvania, rises in three branches in the southeastern part of McKean County. From the junction of these streams south of Norwich village, Potato Creek flows northward passing through Smethport borough and then turns northeast flowing into the Allegheny River about 272 miles above its confluence with the Monongahela.

The largest tributary of Potato Creek is Marvin Creek which rises in the south central part of McKean County and flows in a northeasterly direction a distance of fifteen miles, entering the main stream at Smethport borough.

Potato Creek during its course traverses twenty-four miles. During the first six miles it falls at the rate of ninety feet to the mile, while from Norwich to its confluence with the Allegheny, the fall is nine feet to the mile. At its mouth the creek is about thirty feet wide.

The valley of this creek above Smethport is narrow with steep sides and the drainage area is mainly covered with underbrush. Below Smethport the valley becomes wide and level, the hills on the east being wooded while those to the west are barren. Potato Creek drains an area of 240 square miles, practically the whole southeastern portion of McKean County. The basin is comparatively rugged and precipitous and is mostly covered with brush and small forest, but a small portion, probably a quarter of the immediate valley, is farmed. Underlying the basin are found shales of the Chemung series and the soil is everywhere of slight depth; beneath the soil sandstone and slate are found in quantities. At the headwaters of Potato Creek in southeastern McKean County is found the largest section of virgin timber left in Pennsylvania, in all about 40,000 acres. The valley through which the extreme headwaters of this stream flow is not deep but is narrow and the sides steep.

Although well adapted for water power installation, the stream is not used for water power on account of the small population along its banks. This stream has been declared a public highway from its mouth to Smethport Borough and Shippen Road. The total population of the basin is about 7,520, divided as follows: urban 2,000, rural 5,520. The rural population is approximately twenty-four to the square mile.

There is no important city within the watershed, Smethport, with a population of 2,000, being the largest place. This is a manufacturing town picturesquely situated in the valley of Marvin and Potato Creek and is surrounded by towering mountains. Potato Creek is polluted practically throughout its length, chiefly by mine wastes from mining operations at Clermont and a chemical works at Newerf.

The rainfall records at Smethport, near the middle of the drainage area, covering seven years completely and a total period of twenty-one years, give the following: Annual precipitation in inches—maximum 47.35 inches; minimum 30.65 inches; mean for total period 41.61.

There are two water power developments on the watershed, both on Marvin Creek at Smethport, one operating a grist mill and the other owned by the Smethport Water Company. The industries in this division include three glass plants at Smethport and three at Hazlehurst, as well as the following chemical plants: Newerf, Hineman Chemical Company; East Smethport, Hineman Chemical Company; Crosby, Hineman Chemical Company; Marvindale, Marvindale Chemical Company; Clermont, Quinn and Sherman.

There are a number of railroads, especially in the western portion of this watershed, for the greater part originally lumber roads. There are about seventy-five miles of railroad in all, including a branch of the Pittsburgh, Shawmut and Northern, following the creek from its mouth to the headwaters of the west branch, and a branch of the Pennsylvania extending from the mouth to Smethport and thence up the east branch, crossing the divide at Clermont. There are three systems supplying the public with water. The Hazlehurst Water Company at Hazlehurst, the Smethport Water Company at Smethport, and the Crosby Gas Company at Newerf, and an industrial supply is derived from Potato Creek at East Smethport by the Hineman Chemical Company. It is estimated that domestic sewage is contributed by a population amounting to about 2,550 persons, 2,000 of which represents sewage pollution at Smethport. All the chemical plants, five in number, which are mentioned above, contribute more or less of offensive and destructive wastes to the stream.

Newerf, McKean County, is a village with a population of about 200 at the headwaters of the east branch of Potato Creek in the southeastern part of the county. The principal industry is a chemical

plant of the Hineman Chemical Company. The Crosby Gas Company has a private water supply furnishing the public, its source being springs and the system including a 4,500 gallon reservoir.

Hazlehurst, McKean County, is a village with about 1,000 inhabitants, situated near the headwaters of the west branch of Potato Creek in the south central part of the county about three miles east of Mt. Jewett. Its industries include three glass plants, one for the manufacture of window glass, one bottle glass works, and one machine blown glass works. The Hazlehurst Water Company supplies the public and two of the glass plants with water derived from springs and from the headwaters of Marvin Creek. Two reservoirs and a storage tank afford storage facilities for 178,000 gallons of water and the industrial consumption at the window glass works is estimated to be 15,000 gallons and at the bottle glass works 7,500 gallons a day. The machine blown glass works has a private industrial supply derived from Head Run.

Smethport, the county seat of McKean County, is a borough with about 2,000 population in the eastern part of the county at the junction of Marvin and Potato Creek; extending principally along the former. The important industries comprise the Birney-Bond Glass Company, the Smethport Cut Glass Company, the Smethport Glass Company, and several minor plants including a creamery, novelty works, planing mill and flour mill. About a quarter of a mile to the east, at East Smethport, is the Hineman Chemical plant. Water is supplied to the public by the Smethport Water Company, which derives its supply from Blacksmith Run and one of its tributaries, Sheldon Brook, and from two wells near Blacksmith Run. The watersheds are practically uninhabited, and the supply is considered good, and is used by about nine-tenths of the population. There are a few wells in use, though springs are used to some extent. The industrial plants generally use the public supply, but the Hineman Chemical Company at East Smethport uses Potato Creek water for condensing purposes. The borough has a combined sewer system serving practically the entire town comprising about four miles and a quarter of sewer discharging through two outlets into Potato Creek. There are also some seventy private sewers and drains discharging into the highways or streams within the borough. Practically the entire population, therefore, pollutes the stream. The Hineman Chemical Company discharges the characteristic wastes from plants engaged in the manufacture of wood alcohol and acetate of lime.

In a permit issued to Smethport by the Commissioner of Health, June 30th, 1909, the following discussion was offered relative to the discharge of sewage into the streams in the district:

"Potato Creek is an important tributary of the Allegheny River. It is free from mine drainage pollution and before the building of the chemical plants along its banks it was one of the purest mountain streams. The waters of this stream are not used directly as a source of drinking supply for any towns. At the borough of Warren, the county seat of Warren County, Pennsylvania, the Allegheny River is the source of the entire supply for the town during the dry months in the year, and it is used to some extent every month in the year.

"In New York State, at Salamanca on the Allegheny River about thirty-seven miles below the confluence of Potato Creek with the Allegheny, municipal sewage is discharged into the river. Recently the authorities of that place were required by the State Department of Health of New York to re-design the sewerage system and to build extensions thereto in contemplation of the purification of the sewage. Other municipalities along the Allegheny River are being required by the New York State authorities to prepare to dispose of their sewage otherwise than by discharging it into the stream. This policy is a co-operative one adopted by New York and Pennsylvania to bring about the preservation of the purity of public waters for the protection of the public health.

"In Pennsylvania, in McKean County, the city of Bradford has been given permission to extend its sewer system and to discharge the sewage therefrom into a tributary of the Allegheny River until May first, nineteen hundred and eleven.

"The borough of Kane, McKean County, has been given permission to extend its sewer system and to discharge sewage into a tributary of the Allegheny River until May first, nineteen hundred and eleven, and other places in the Allegheny Basin have been given similar privileges under certain conditions which contemplate the ultimate treatment of the sewage.

"The assessed valuation of property in Smethport is reported to be four hundred and eighty thousand dollars in round numbers. The bonded indebtedness is thirty-four thousand. If these figures be correct, the constitutional limit of indebtedness of the borough has been reached.

"It would appear to be in the interest of public health to permit the sewers to be extended as proposed, but the sewage should not indefinitely be discharged into the stream.

"The town should devise ways and means of treating the sewage. Roof and storm water should be excluded from the sewers in so far as it is practicable now. It is not feasible to purify large quantities of sewage and storm water, therefore the storm water should be excluded from the sewers or reduced to a minimum at the time when the sewage must be treated.

"It does not necessarily follow that Smethport cannot treat its sewage because its limit of indebtedness has been reached. The local authorities should take up this question and thoroughly discuss it and arrive at conclusions and prepare plans and submit them to the State Department of Health for approval.

"Because the waters in this region are not polluted with sewage is the best reason why they should be kept free of pollution. To adopt a plan and carry it out prudently now is to assure efficiency and economy to the taxpayers, and the smaller the community, the more careful should it be in its expenditures. The State Department of Health will be glad to advise and co-operate with the local authorities in the solution of the problem."

The village of Norwich, in Norwich Township, in June, 1911, was a settlement of about forty frame dwellings, mostly owned by the Goodyear Lumber Company. This company owns more than a thousand acres of virgin forest land largely within the drainage area of Potato Creek. It owns the town site of Norwich Post Office, otherwise the village of Norwich, and is developing it in connection with lumbering operations. An ultimate population of about 1,200 persons is looked for. Water from springs on the hillsides is piped into the houses. The Commissioner of Health, on August 17th, 1911, refused to permit the said company to build a sewer system and discharge the sewage into the creek. The company therefore prepared plans for sewerage and sewage disposal works, the latter to consist of septic tanks and sand filter beds. The plans were approved August 18th, 1911, and at the close of the year 1912 the sewers and disposal works were built and partly in operation.

At Belle Camp, in Foster Township, McKean County, in the Potato Creek drainage area there is a small institution, operated by the Northwestern Tuberculosis League, whose sewage is connected to and treated in an institutional plant.

(c) *Typhoid Fever.* The cases of typhoid fever reported by the local health authorities of Eldred and Smethport Boroughs to the State Department of Health from 1906 to 1912, inclusive, are given in the following table:

Typhoid Fever Cases Reported for the Section of the Allegheny Basin from Potato Creek to Oswayo Creek, 1906-1912, inclusive.

Town.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
Eldred,	0	0	0	1	11	17	2
Smethport,	0	1	4	3	0	0	0

Section 3.—Oswayo Creek to Tunungawant Creek.

(a) *Along Allegheny River.* Below the junction of Oswayo Creek the Allegheny River flows in a general westerly direction, with three long gentle bends, through the southeastern part of Cattaraugus County, New York, where it is joined by Tunungawant Creek coming from the south. During the first part of its course in this section the river passes through a wide valley with high hills on either side. The side slopes are well farmed while the hill-tops are bleak and barren, the result of forest fires following tan bark operations. From Olean to the junction of the Tunungawant the valley of the stream is comparatively flat and about two miles wide, while the river itself averages 300 feet in width and has a fine, sandy, gravel bottom. Part of the flats to the south of the river are farmed, but there is considerable waste land found here, while the slopes north of the river are covered with a scrub growth of timber. South of the river near Allegany, there are numerous oil wells but of late years this industry has fallen off to a considerable extent. In this section of the river dams and cribs are found in the channel, the remains of extensive lumber operations.

The total population of this portion of the Allegheny River Basin is 36,420 of which 22,020 are urban and 14,400 rural. Olean, New York, with a population of 16,920, is the largest town, and is situated on the river at a point 55 miles from its source. There are a number of tanneries in its immediate vicinity, this being one of the chief industries.

The largest tributary streams to the river within this section, taken in order down stream, are Dodges Creek, Haskell Creek, Olean Creek and Six Mile Creek. All enter from the north, the first two traversing fertile valleys with no villages and gradual slopes. Olean Creek, the largest of these, rises about sixty miles north of Olean and flows in a general southerly direction entering the river at Olean. It is made up at Hinsdale of two tributaries, Oil Creek which rises in a small lake at an elevation of 1,560 feet, and Ischua Creek, the main branch from the north. The mountains rise abruptly from the valley bottoms and small torrential tributaries enter these streams from their steep slopes. The flow of Olean Creek and consequently of the river is somewhat modified by the Cuba Reservoir, so-called. The storage is commonly turned into the Genesee River through the abandoned summit level of the Genesee Valley Canal, but may be diverted into Olean Creek through the guard lock at the head of the canal. It is not likely that the flow from this source materially affects the low water flow of the Allegheny River. The only power development noted is at Westons, New York, where a dam on the river gives a fall of from eight to ten feet, utilized by a large saw mill.

Oil production has a marked effect on the condition of the water in the streams receiving wastes from these operations. Olean has become a centre for oil distribution, at one time 300 tanks with a capacity of 9,000,000 gallons being in use. Beginning at this point there are two six-inch pipe lines extending to the seaboard through which 35,000 barrels of oil a day can be delivered.

A 5,000 barrel oil refinery at Olean, a tannery at White House, five tanneries at Olean and one at Allegany as well as a chemical plant at South Vandalia contribute manufactural wastes which in various ways affect the stream. The wastes from the tanneries alone amount to probably ten cubic feet a second. The tannery of Adam Kinley & Sons on Two Mile Creek at Olean has installed settling tanks resulting in a radical improvement of the character of that small tributary. Domestic sewage is contributed by about 15,000 persons, 3,000 of whom are on Olean Creek.

Water supplies are in no case derived directly from the river, mountain streams, springs and wells being the chief sources. Nearly a hundred miles of railroad traverse this territory, including the Pittsburgh, Shawmut and Northern, Erie, and Buffalo Division of the Pennsylvania, and a portion of the Buffalo, Rochester and Pittsburgh Railroads, Olean being an extensive railroad centre. In addition to the steam roads there are many miles of inter-urban electric lines connecting Olean with Salamanca and Little Valley in New York State, and Bradford and Shingle House in Pennsylvania.

Portville, Cattaraugus County, New York, is an incorporated village with a population of about 770, situated on the Allegheny River a mile below the mouth of Oswayo Creek. There are a few private sew-

ers and cesspools in the village and it is estimated that about 420 persons contribute sewage to the river. There is a tannery at this point discharging its wastes into the river.

Cuba, Allegany County, New York, is an incorporated village with a population of about 1,520 on Oil Creek which is a tributary of Olean Creek which latter enters the Allegheny River at Olean. The population contributing sewage to the stream is estimated to be 840. Plans for a separate sewerage system providing for septic treatment were approved by the New York Department of Health on April 26, 1904.

Franklinville, Cattaraugus County, New York, is an incorporated village with a population of about 1,480, and has an estimated polluting population of 810. The village has no sewerage system.

Olean City, Cattaraugus County, New York, has a population of about 16,920, including that part of the city formerly known as North Olean. The city is provided with combined sewers, but the New York State Department of Health has required that future extensions to the sewer system shall be on a separate plan and so constructed as to provide for the future treatment of the sanitary sewage. The former village of North Olean has a comprehensive separate sewer system including two disposal plants serving in all a population of about 1,700 persons. The disposal plants consist of septic tanks and sprinkling filters, one discharging the effluent from about 200 persons into Two Mile Creek and the other serving about 1,500 persons and discharging into Olean Creek. The population contributing sewage to the Allegheny River from Olean is estimated at 11,590. The water supply of Olean is derived from driven wells along the bank of the river. Five tanneries in the city or vicinity discharge characteristic wastes into the stream.

Allegany, Cattaraugus County, New York, lies about four miles below Olean on the Allegheny River. It is an incorporated village with a population of 1,330. The New York Department of Health has approved plans for a comprehensive sewerage system providing for ultimate septic tank treatment of the sewage.

(b) *Oswayo Creek Drainage Area.* Oswayo Creek rises in two branches in the northwestern corner of Potter County, heading close to the sources of the Genesee and Allegheny Rivers. The north branch rises in the Oswayo Range and flows through a deep canyon its entire length. The south branch rises in the rolling lowlands near East Hebron but soon enters and cuts across the Oswayo Range, forming a confluence with the north branch at Coneville. The stream from this point takes a general northwesterly direction crossing the eastern boundary of McKean County two miles south of the State line and leaving McKean County six miles west of its northeast corner. Here it enters New York State and shortly afterwards joins the Allegheny River in the extreme southeastern corner of Cattaraugus County,

258 miles from the mouth of the Allegheny River. The greater part of this basin is traversed from side to side in a northeast southwest direction by six ranges of broad table-lands.

The natural flow of the headwaters of Oswayo Creek is rapid but below the junction of the two branches the valley widens, becoming broad, flat and swampy, with sharp bluffs on either side and here the flow is extremely sluggish. The area drained by the Oswayo Creek comprises 218 square miles, of which about seventy-nine are in New York State. This creek is the largest tributary of the Allegheny in this section. During its course it traverses twenty-five miles almost entirely in Potter County. The total population of the basin is 8,210, divided as follows:

New York—Urban, 1,750; rural, 2,660. Pennsylvania—Urban, 1,850; rural, 2,080.

The rural population is approximately twenty-one to the square mile.

Shingle House in Potter County, Pennsylvania, and Bolivar in Allegany County, New York, are the only towns on the watershed having a population of over 1,000.

This stream has been declared a public highway from the New York State line to the junction of its forks, a distance of twenty miles. The watershed of the Oswayo is probably the wildest and least developed section of the Allegheny Basin. There is a sewerage system at Shingle House. The ground in the basin is not extremely fertile and these facts taken together with the sparse population living on the shed clearly indicate the favorable character of the water.

The rainfall records at Shingle House cover a total period of eight years for which four years' records are complete. The annual precipitation in inches is: maximum 48.29, minimum 37.35, mean for total period 38.63.

There is a small water power development at Shingle House on Oswayo Creek operating a grist mill.

Farming is the principal occupation on this watershed, although the presence of gas in large quantities, now gradually diminishing, has until recently forced agriculture to the background.

The New York and Pennsylvania Railroad follows Oswayo Creek practically throughout its entire length and a branch of the Pittsburgh, Shawmut & Northern extends up Little Genesee Creek, making a total of about thirty-five miles of railroad.

Oswayo has a spring water supply furnished to the public by the Oswayo Water Company and at Shingle House the public is supplied with driven well water and spring water by the Palmer Window Glass Company and the Shingle House Water Company. It is estimated that about 4,310 persons in New York State and 3,930 persons in

Pennsylvania or 8,240 in all contribute sewage to the creek. So far as known, the only industrial wastes of importance are those discharged from the chemical plant near Oswayo.

Richburg, Allegany County, New York, is an incorporated village near the headwaters of Little Genesee Creek, a tributary of Oswayo Creek, entering the latter stream near the State line. The population is about 380 and while the village has no sewer system, it is estimated that probably 200 persons contribute sewage to the stream.

Bolivar, Allegany County, New York, is an incorporated village with a population of about 1,370. A separate sewerage system and disposal plant have been designed and a permit for the construction was issued by the New York Department of Health on February 7th, 1907. The purification plant includes septic tanks and contact beds. The daily estimated flow of sewage from the village is 200,000 gallons. A private corporation supplies water to the public, the daily consumption being about 350,000 gallons.

Oswayo, Potter County, is a small rural community near the headwaters of Oswayo Creek. Its population of 450 persons is engaged chiefly in farming, but there is also at this point a grist mill and a heading mill. A chemical plant nearby discharges characteristic wastes into the creek. The public is supplied with water by the Oswayo Water Company, which has two reservoirs of 8,000 and 5,000 gallons respectively, both fed by springs. Only a small portion of the population, perhaps fifty persons, contribute sewage pollution to the stream.

Shingle House borough, Potter County, with a population of about 1,400 is situated near the northwest corner of Potter County at the junction of the Honeoye and Oswayo Creeks and about nine miles above the mouth of the latter stream. Its principal industries are the Elk Flint Bottle Works, employing from seventy-five to a hundred men, the Sharon Manufacturing Company's heading mill with about fifteen employees, and a grist mill with about five employees. Until recently the Palmer Window Glass Company gave employment to several hundred men, but the closing down of the plant has reduced the population of the borough from 1,600 to its present number, about 1,400. The borough owns its own system of water pipes, but water is furnished and the system operated by the Palmer Window Glass Company, deriving its supply from three driven wells on the company's ground. The Shingle House Water Company, a private concern, has been organized and will furnish water and operate the borough's system. The supply will be derived from springs on the mountain side augmented by a driven well within the borough and delivered to about 600 consumers, while the Palmer Window Glass Company will continue to serve about 200 persons for a time at least. The borough has a combined sewerage system serving a large population, although privies are quite generally used.

(c) *Typhoid Fever.* From 1906 to 1912, inclusive, the local authorities of the boroughs of Oswayo and Shingle House have reported to the State Department of Health one case of typhoid fever from Oswayo and seven cases of typhoid fever from Shingle House. These are the only towns of importance in Pennsylvania in this section of the Allegheny Basin.

Section 4.—Tunungawant Creek to New York-Pennsylvania State Line.

(a) *Along Allegheny River.* After its junction with Tunungawant Creek the Allegheny River flows in a general northwesterly direction to Salamanca, New York, where, in a long bend, it turns southwest and crosses the New York-Pennsylvania State Line, 94.3 miles from its source and 213.7 miles above its mouth. At the mouth of the Tunungawant Creek the valley is about two miles wide and the river about 200 feet wide. This width is nearly uniform to the State line and the fall during this distance averages 3.7 feet to the mile. The valley is flat and marshy with high hills covered with a second growth on either side. Near Salamanca the condition remains the same, but from Red House to the State line part of the land is farmed though most of it is covered with remains of early tan bark operations. Great Valley Creek, the largest tributary of this section of the river, drains the south central part of Cattaraugus County, New York. It rises in an extensive hemlock swamp and flows for its entire length through a broad, flat, well farmed valley with low, rolling, partly wooded hills on either side. The total population of this division of the watershed is 17,870, divided as follows: urban, 9,830; rural, 8,040. Salamanca, with a population of 7,000, situated on the river in the south central part of Cattaraugus County, New York, is the largest town in this section and contains the only tannery in the territory.

At Salamanca the elevation of the river is 1,381 and at Corydon, twenty-three miles down stream, where the river re-enters Pennsylvania, the elevation is 1,289, a drop of ninety-two feet or four feet to the mile.

At Salamanca, Great Valley Creek enters from the north, draining an area of 130 square miles and extends with its West Branch almost to the headwaters of Ischua Creek. Little Valley Creek, entering from the north at West Salamanca, drains an area of about fifty square miles and has a minimum flow of 6.3 cubic feet a second. There are a number of other small creeks which enter from both sides, all more or less torrential and of minor importance. The river is

not used for navigation, although it is a matter of record that many years ago a steamer ascended the river from Pittsburgh to Olean. This appears to have been a single performance, probably never accomplished again. There is no water power development along this section in use at the present time, a small dam at Corydon having been washed out some years ago.

There is an Indian Reservation along the Allegheny River for a distance of forty miles north of the State line and extending for one-half mile on each side, thus including the village of Salamanca. The land can only be leased from the Indians and for this reason development is not active.

This territory is well supplied with transportation facilities, having about ninety miles of railroads, including portions of the Erie, the Buffalo, Rochester and Pittsburgh, and the Buffalo Division of the Pennsylvania Railroad. In addition to the steam roads an inter-urban trolley line extends from Little Valley to Salamanca and thence to Olean.

The New York State Health Department report for 1908 states that "Except for the oil on the surface of the water, the Allegheny should be clear and wholesome water, supplied as it is from springs of the mountains, and comparatively unpolluted by human wastes. Actually, it is, under its normal conditions, very dark colored and foul smelling, with decaying organic matter in suspension constantly in evidence. The inspector reports that in many of the eddies, and in the still water behind islands, and generally in quiet reaches of the river, conditions are found revolting in the extreme to the senses both of sight and smell. He reports that the presence of raw sewage from Olean was noticed at least ten miles down stream, and that similar conditions exist at Salamanca. There seems to be a lack of oxygen in the water, for the lack of which the organic matter is not absorbed and oxidized. The discoloration may be due in part to the vegetable color which it receives in passing through the swamps and mountain timber, but the largest part is contributed in the form of tannery wastes."

The tanneries in this division, two in number, are located at Salamanca and at Red House. There is a chemical plant on Red House Creek, wastes from which are characteristic and considerable. The combined liquid waste from the tanneries is estimated to be three cubic feet a second. A condensed milk plant at Ellicottville is also a source of pollution but of minor importance. No public water supplies are derived from the stream.

Ellicottville, Cattaraugus County, New York, is an incorporated village, with a population of 1,040. It has a few private sewers discharging into Great Valley Creek.

East Salamanca, Cattaraugus County, New York, is an unincorporated village provided with a comprehensive combined sewer system for which plans were approved by the New York Department of Health in 1908. The permit requires that future extensions shall be made on the separate plan and that the treatment of the sewage shall be accomplished at such time as the village of Salamanca shall be required to treat its sewage.

Salamanca, Cattaraugus County, New York, is an incorporated village, with a population of about 7,000, situated on both banks of the Allegheny River, about six miles below the mouth of Tunungawant Creek. The river here receives the manufacturing wastes from a tannery and the sewage of about 5,000 persons. The New York Department of Health, on March 26th, 1908, approved plans for a comprehensive sewerage system and issued a permit allowing the discharge of sewage from this system into the Allegheny River, until such time as the State Commissioner of Health shall require the construction of disposal works.

Little Valley, Cattaraugus County, New York, is an incorporated village, with a population of about 1,230, situated near the headwaters of Little Valley Creek, a small stream entering the river at West Salamanca. The village has no sewers. It is estimated that 680 persons pollute the creek with sewage.

West Salamanca, Cattaraugus County, New York, is an incorporated village, with a population of about 560, situated at the mouth of Little Valley Creek. No plans for sewerage and disposal works have been submitted to the New York Department of Health. It is estimated that 310 persons discharge sewage into the stream.

(b) Tunungawant Creek Drainage Basin. The Tunungawant Creek is formed by the junction of its East and West Branches at Bradford, in the northern part of McKean County, at a point two miles and a half south of the boundary line between the States of New York and Pennsylvania. Neither one of these tributaries is an important stream. The East Branch rises in the mountain twelve miles south of Bradford and flows in a northerly direction. The West Branch has its source seven miles southwest of the city. Both of these branches flow through narrow valleys with steep sides, the drainage area having been denuded of forest is now covered with second growth.

From Bradford, the Tunungawant Creek flows northeast for one mile and then north across the State line into New York State, joining the Allegheny at South Carrollton, New York, eleven and a half miles below Bradford, and 241 miles from the mouth of the Allegheny River.

The dividing ridges surrounding the drainage areas are almost level. Below Bradford the ground along the Tunungawant Creek is from five to ten feet above the ordinary water level of the stream and is subject to inundation. Along the eastern bank of the creek the surface rises rapidly for one mile below the junction where it reaches an elevation of 350 feet above the city, while on the north-western bank of the main stream the surface ascends gradually to an elevation of 250 feet above the city.

The valley at the mouth is about half a mile across, while the creek itself is about thirty feet wide. On the hilltops throughout the length of the creek, second growth timber is found to a considerable extent, while on the slopes there are occasional farms.

Tunungawant Creek drains an area of 164 square miles of which about twenty-four are in New York State. The average fall of the headwaters for the first six miles is at a rate of sixty-four feet to the mile and from then on to the State line the fall is sixteen feet a mile as the valley widens and is more gradual in slope.

This basin was the scene of great activity and became widely known and thoroughly prospected during the Bradford oil excitement. The oil field is about thirty miles long and from six to fifteen miles wide—Bradford is in the northeastern corner of the field. The entire section is honey-combed with oil and gas wells, nearly all of which are small producers at the present time.

The total population of the basin is 24,410, divided as follows:

New York—Urban, 720; rural, 510. Pennsylvania—Urban, 17,500; rural, 5,680. The rural population is approximately thirty-seven to the square mile.

The only tannery on the shed is situated at Limestone, New York, one mile north of the State line. Bradford City, with a population of 17,500, is the only municipality in the basin and is the oil centre of this district. It is an enterprising and rapidly growing community, exceedingly irregular in shape, owing to the fact that the development of the town has been along the streams in the valleys and on the adjacent hillsides.

No rainfall records are available for points within the Tunungawant watershed. The records at Smethport, near by, may be considered as approximately correct for this area as well. These are complete for seven years and cover a total of twenty-one years, giving an annual precipitation in inches of, maximum, 47.35; minimum, 30.65; and mean for total period, 41.61.

Trout have been used exclusively by the State Fish Commission in stocking the streams on the Tunungawant Creek watershed.

A development on the west branch of the Tunungawant Creek, near Bradford, is the only utilization of the stream for a water power. Industrially, the production of oil and its refinement and allied inter-

ests are dominant, while plants for the manufacture of wood alcohol are of especial importance in the consideration of stream pollution.

The Erie Railroad and the Buffalo, Rochester and Pittsburgh Railroad operate parallel lines practically throughout the course of the creek, the total length of railroad within the watershed amounting to about forty-five miles. The only public water supply of record is that of Bradford City, which is derived from the uninhabited watersheds of Gilbert and Marilla Brooks, augmented by driven wells. Up to a quite recent date there was but one industrial supply, that of the U. S. Pipe Line Pumping Plant, on Kendall Creek, which uses the water of that creek for boiler purposes.

Domestic sewage is discharged into the stream directly or indirectly by about 400 persons at Limestone, and 17,500 at Bradford. Industrial wastes of importance are contributed by the tannery at Limestone, by the Dupont Nitroglycerine Works at Custer City, and by the following chemical plants manufacturing wood alcohol and acetate of lime: Bradford, A. B. Smith Chemical Company; Bradford, Nussbaum Chemical Company; Custer City, Custer City Chemical Company; Degolia, Minard Run Chemical Company; Degolia, American Acid & Alkali Company; Taintor, Taintor Chemical Company; Lewis Run, Lewis Run Manufacturing Company.

The chemical plant wastes have been discussed elsewhere in this report and will be the subject of further investigation by the Department. Owing to the extensive production of oil throughout the valley of Tunungawant Creek, wastes wash down with every rain and oil is constantly present and perceptible on the water of the creek, especially in the lower portion of its course.

Limestone, Cattaraugus County, New York, is an incorporated village, with a population estimated at about 720, and situated about one mile north of the State Line on Tunungawant Creek. There is no comprehensive sewerage system in the village and the question of sewerage has not been taken up with the New York State Department of Health, but it is estimated that a population of about 400 contributes sewage either directly or indirectly. A large tannery at this point discharges characteristic wastes.

Custer City, McKean County, a small village with about 300 inhabitants, situated on Tunungawant Creek, about four miles above Bradford, is in the heart of a rich and active oil field, oil production being its chief industry. The Custer City Chemical Company operates a wood alcohol plant at this point and the Dupont de Nemours Powder Company has a nitroglycerine plant.

The city of Bradford, McKean County, has a population of about 17,500, and is situated on Tunungawant Creek, about three miles south of the State line. Petroleum and natural gas are found in abundance in this vicinity and these resources form the basis for the

greater portion of the industries. There are five large establishments manufacturing oil well supplies, two oil refineries, repair shops of the Erie and B. R. & P. Railroad Companies, silk mills, two cutlery works, one extensive foundry, a machine shop, a glass factory, one terra cotta works and five miscellaneous plants. Bradford has a municipal water system, said to be self-supporting. It serves practically the entire population, about 650 persons obtaining their drinking water from wells and springs. The system comprises perhaps twenty-two miles of street mains, two impounding reservoirs, one distributing reservoir, drilled wells, pumping station and two lines of gravity supply mains to the city. Water is derived from Marilla Brook and one of its tributaries, Gilbert Brook, the reservoir being located about five miles west of the city. This supply is augmented by ground water from six drilled wells, located in the valley of Marilla Brook immediately below Reservoir No. 3. The city owns and controls some 8,000 acres or practically the entire watershed, which is well timbered and uninhabited. About twenty-three miles of public sewers serve a large portion of the population and discharge into the creek. About eighteen miles of this system is tributary to one main sewer outlet, the system receiving a comparatively small amount of surface drainage. Beside the public system there are a great many private sewers.

On May 7th, 1908, the Commissioner of Health issued a permit to the city of Bradford for the construction of certain sewer extensions and requiring that comprehensive plans for a sanitary sewerage system and disposal works for the treatment of all of the sewage of the city be prepared and submitted for approval on or before May 1st, 1909. The industrial plants in Bradford, though extensive, appear to discharge wastes of little or no importance, with the exception of the A. B. Smith Chemical Company and the Nussbaum Chemical Company.

In a decree issued by the Commissioner of Health to Bradford city, in April, 1912, approving plans for a comprehensive sewerage system and sewage disposal works, the following discussion may be found relative to the State's policy concerning the discharge of sewage into streams in the neighborhood:

"The Allegheny River and its tributaries in McKean County and vicinity are comparatively free from such pollution as can, in a great measure, be eliminated. It is the policy of the Commonwealth to preserve the purity of the waters of the State for the protection of the public health, and, in conformity with this policy, no more sewage should be discharged into State waters, but, to the contrary, there should be progress made in taking out sewage now going into streams.

"The industrial pollutions of the Allegheny River and its tributaries above Warren consist largely of oil and the troublesome "rod wax", a greasy deposit consisting largely of paraffin washed down with every rain from the vicinity of the oil wells: also tannery wastes and particularly tar and dilute acids from chemical and acid manufacturing plants. The Department is making efforts to reduce these pollutions, especially the creosote, which imparts a disagreeable taste and odor to the water at Warren, where the river is the source of supply to ten thousand people.

"In Tunungawant Creek, aside from the oil production wastes generally in evidence on the surface, the more extensive pollutions include sewage from Bradford city, and, to some extent, from private sewers in Limestone village, New York, and industrial wastes from a tannery at Limestone, two oil refineries at Bradford, an acid plant on the East Branch just above the city and three chemical plants, two on the East Branch and one on the West Branch, all above the city. Two other chemical plants on the East Branch have, at the instigation of the Department, installed the necessary apparatus to prevent their wastes entering the stream. The Emery Refinery, at Bradford, is installing apparatus to prevent pollution of the water by that plant.

"Bradford must, necessarily, build a larger plant for the treatment of its sewage than other towns of the same size, because of the poor condition of its sewers and the fact that it does not have money to reconstruct the sewers and eliminate storm water from them. There will be some storm overflows required, probably for a number of years, along the proposed intercepting system.

"The emergency shear gates proposed to permit the discharge of sewage through the weir walls directly to the creek, at the two proposed overflow main outlets on the east and west main interceptors, are superfluous and should be eliminated because there are overflows anyway. Shear gates will permit the intentional or careless discharge of part or all of the sewage to the creek at any time when the object of the intercepting sewer is to convey the sewage below the town to the site of the sewage disposal works.

"So long as storm water shall be admitted to the sewer system there will be an occasional discharge of sewage into the stream, and the danger of contamination of the river water with germs of disease will be ever present. Practical considerations seem to indicate that it will be expedient to permit the construction and temporary use of the proposed overflow manholes, provided the city shall exercise diligence in reducing the amount of storm water admitted to a minimum. When this shall have been accomplished, the overflows will come into operation only in the event of serious damage to the outfall sewer, and this seems a very remote possibility.

"The minimum dry weather flow in Tunungawant Creek, past the point where the proposed main sewer overflows will be located probably, does not exceed ten cubic feet per second, an amount about equal to the capacity of the proposed main outfall sewer. The minimum run-off below Foster Brook, which enters a short distance down-stream from the sewage disposal site, is probably less than fourteen cubic feet per second. These estimates are based on a minimum run-off of one-tenth second foot per square mile of drainage area.

"The city of Bradford should prepare to secure partial treatment of its sewage. Effective screening or sedimentation and disinfection will materially improve the quality of the water in the creek.

"The site selected for the disposal works is in many respects adapted for the purpose. It is fairly well isolated, but it appears that other sites have not been carefully considered and it may be that there are other places that are better adapted for the erection of sewage disposal works than the one determined upon. This matter should be given further consideration."

(c) *Typhoid Fever.* The cases of typhoid fever reported by the local authorities of Bradford city to the State Department of Health, for the years 1906 to 1912, inclusive, are given in the following table:

Typhoid Fever Cases Reported for Bradford, 1906—1912, inclusive.

Town.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
Bradford City,	30	2	19	7	16	18	5

Section 5.—New York State Line to Conewango Creek.

From the State Line the Allegheny River flows in a long gentle bend through the extreme eastern part of Warren County to where it is joined by Kinzua Creek. Here it turns to the west and follows this direction to Warren, the point of confluence of the Allegheny

River and Conewango Creek. Just below the State Line, above Gawango, the hills for the first time converge on the river banks, until the valley is but a quarter of a mile wide and there is a sudden change in the profile of the river, for the rate of slope for twenty miles below the State Line increases to five feet a mile. During this part of its course the bed of the river is covered with gravel, except at Limestone Falls, where a solid ledge of limestone underlies the river bed and the descent is 3.84 feet in a distance of 650 feet. Throughout these twenty miles the pools between the rapids are shallow, rarely exceeding five feet in depth. About ten miles above Warren loose rocks begin to make their appearance in the bed of the stream. The flats along this section of the river are fairly well farmed, but the hills are usually steep and wooded. Below Sugar Run, oil wells are found all along the river to Warren.

Kinzua Creek, the main tributary of this section of the river, rises in the southwestern part of McKean County and flows in a general northwesterly direction to its confluence with the river in the extreme eastern part of Warren County. The valley of this creek is steep, rugged and covered to a considerable extent with underbrush. At its mouth Kinzua Creek is about fifty feet wide and fairly clear. The total population of this section of the Allegheny River, principally in the Kinzua Drainage Basin, is 20,740, of which 11,300 are urban and 9,440 rural. Tanneries are located at Mt. Jewett, Stoneham, and Glade.

More than nine-tenths of the total area in Kinzua Creek drainage basin is still wooded. The farms are generally poor, the owners raising only enough for home consumption. They depend for a livelihood on the forest industries, or on the oil and gas now less abundant in the territory, or are employed in the large chemical mills.

Neither the river nor its tributaries in this section are used for navigation or water power purposes.

The presence of tanneries and chemical plants has destroyed the fish in the larger streams but the smaller afford excellent trout fishing.

That portion of the area lying in McKean County contains considerable second growth timber which is largely used for the manufacture of wood alcohol, engaged in the production of which there are eleven chemical plants. Chemical plants, tanneries and glass works form the most important industries. The Chautauqua Division of the Pennsylvania Railroad follows the Allegheny River throughout this section, with branches extending up Kinzua Creek toward Mt. Jewett and southeast from Warren toward Kane. There are a number of minor roads formerly used in timber developments. The total mileage of railroads amounts to about 116 miles.

The only large public water supply is derived from an intake on the Allegheny River at Glade from which the city of Warren receives an emergency supply. The water is subjected to mechanical filtration.

A population of over 5,000 persons at Kane and Mt. Jewett contribute sewage to the stream by way of Kinzua Creek. Manufactural wastes form a very extensive pollution seriously menacing the water supply of Warren. These wastes come from the tanneries and chemical plants.

The tanneries are three in number, one at Glade and one at Stoneham (both plants of the Elk Tanning Company), and one at Mt. Jewett, owned by the Mt. Jewett Tanning Company.

The chemical plants, eleven in number, are as follows:

Place.	Name of Company.
Kushequa,	National Chemical Company.
Kushequa,	National Chemical Company.
Newton,	Newton Chemical Company.
Mt. Alton,	John Barkley Chemical Company.
Bond Vein,	Alton Chemical Company.
Kinzua,	Kinzua Chemical Company.
Olivedale,	Olivedale Chemical Company.
Morrison,	Himes Chemical Company.
Westline,	E. L. Day Chemical Company.
Mt. Jewett,	Bradford Chemical Company.
Struthers,	A. B. Smith & Company.

With the exception of the Struthers plant these are all located above the Warren intake and their wastes seriously affect the character of the water and the operation of the filtration works at Warren. The wastes from plants of this kind have been considered in detail elsewhere in this report. The waste water from the Keystone Glue Company, at Glade, amounts to about 100,000 gallons a day and carries much lime and probably contains fine hide trimmings and a considerable amount of hair. The fourteen-inch sewer extending from this plant to the river is provided with catching boxes from which the lime and hair are periodically removed and used for fertilizer.

Mt. Jewett borough is an industrial and railroad town, with a population of about 1,800, situated on a divide, the ground sloping in three directions, from the borough to Potato Creek on the south and east, to Kinzua Creek on the north, and to the west branch of the Clarion River on the southwest. The greater part of the drainage goes to Kinzua Creek. No less than eight railroads radiate from the borough, these having all been started as lumber roads and some of them are still devoted to that industry. It is a terminal point of the Pittsburgh and Western Railroad, a part of the Baltimore & Ohio system; it is also reached by the Erie and the Buffalo, Rochester & Pittsburgh, beside several minor local roads. Its principal industries comprise the plant of the Consolidated Window Glass Company,

employing about 150 men; the Mt. Jewett Tanning Company's tannery and a furniture factory. It is also an oil centre, the production in the vicinity being quite extensive. For domestic use a great deal of water is derived from private wells, while a portion of the population is served by a public system obtaining its supply from springs. The Consolidated Window Glass Company has a private industrial supply furnishing water from wells and springs to its plant. The only wastes of any importance aside from domestic sewage are the extensive wastes from the Mt. Jewett tannery. These enter the Allegheny River by way of Kinzua Creek.

Kane is a borough of about 8,000 inhabitants, situated like Mt. Jewett on the summit of a divide, with drainage in three directions, on the north to Kinzua Creek, on the southwest to Tionesta Creek and on the southeast to the Clarion River. Originally a lumber town, it is now the centre of considerable oil and gas production and an important railroad junction. The Philadelphia and Erie branch of the Pennsylvania Railroad, and the Pittsburgh & Western branch of the Baltimore & Ohio intersect at this point, which is also the eastern terminus of the Kane & Elk Railroad, a lumber road of considerable local consequence. Its industries comprise four window glass plants, two bottle glass plants, brush handle, cutlery, saw tooth, and blind factories as well as repair shops of the Pennsylvania Railroad and of the Standard Oil Company. The inhabitants are largely furnished with water by the Spring Water Company, whose supply consists of wells, springs and surface waters, generally considered to be of good quality and adequate, except during extremely dry seasons. Cess-pools and privies are in general use, many of which overflow and, together with kitchen slops deposited in the gutters in some of the unsewered districts, cause disagreeable and sometimes menacing conditions. The borough has a system of combined sewers in general use, with pipes ranging from six to twenty-four inches in diameter. Two principal outlets, twelve and twenty-four inches in diameter, discharge into Kinzua Creek, about half a mile and two-thirds of a mile, respectively, below the borough line. These two sewers form the outlets of a system comprising about eight miles and a half of sewers and serving about half the population of the town. A ten-inch, a twelve-inch and an eighteen-inch outfall sewer serving a system comprising about a mile and a half of sewers in the western district of the town, discharge into the east branch of Tionesta Creek. The White Rock Land Company also has a sewer in this district, serving some twenty-five houses. The Department issued a permit, on October 8th, 1907, to this land company, permitting temporary discharge of sewage and requiring ultimate disposal, either independently or in co-operation with the borough of Kane. On October 7th, and on No-

venber 9th, 1907, permits were issued to the borough of Kane permitting temporary discharge of sewage and calling for plans for a comprehensive sewerage system adapted to future purification of the sewage. Sewerage plans were submitted and approved by the Department in May, 1908, involving two systems and ultimately two disposal plants, one in the Tionesta Creek district and the other in the Kinzua Creek district. There appear to be no manufactural wastes in the borough which constitute a serious menace.

Stoneham is a village of about 200 inhabitants, situated on the Western Division of the Pennsylvania Railroad, about five miles southeast of Warren. Industrially it depends upon the large tannery of the Elk Tanning Company, the wastes from which have been referred to above.

Glade is a village of about 700 inhabitants, located on the banks of the Allegheny River, some two miles above Warren. Its principal industries comprise the Keystone Glue works and the tannery of the Elk Tanning Company. The tannery has a private industrial water supply system, using water from the Allegheny River. The wastes from these plants are discharged below the Warren intake.

Kinzua is a village of about 600 inhabitants, situated on the river, at the mouth of Kinzua Creek, about ten miles above Warren. The river receives the wastes from a chemical plant at this point.

Table XXXIII indicates the variableness and the quality of the water of the Allegheny River, at the intake of the Warren Water Company, at Warren. These analyses were made by the company's chemist, and are copied from his report.

TABLE XXXIII.—Chemical Analyses of Allegheny River Water at Warren Water Company Station, Warren, Pa. Parts per Million.

Determinations.	Oct. 4, 1907.	Oct. 4, 1907.	Nov. 23, 1907.	Nov. 28, 1907.	Dec. 6, 1907.
Appearance,	Murky.	Cloudy.	Clear.	Clear.	Clear.
Turbidity, .....	.150	0.600	None.	None.	None.
Odor,	None.	None.	Kerosene.	None.	None.
Color,	40.000	20.000	.....	.155	.010
Nitrogen as Albuminoid Ammonia, ..	.280	0.085	.002	.155	.110
Nitrogen, Free Ammonia, .....	.050	.090	.003	.085	.072
Nitrogen Nitrites, .....	.001	.006	.002	.0005	.0051
Nitrogen Nitrates,	Trace.	.000	.400	.7000	.7500
Chlorine,	20.000	12.000	10.000	3.0	6.0
Oxygen Absorbed,	7.800	.700	3.300	3.5	4.1
Total Solids,	115.000	190.000	71.000	116.0	103.0
Iron,	1.000	.250	.400	.3	.400
Alkalinity,	90.000	160.000	30.000	50.0	80.0
Permanent Hardness,	None.	None.	16.000	12.0	19.5
Sulph. Acid (SO ₃),	8.000	8.000	16.000	11.0	13.0
Carbonic Acid,	6.000	6.000	6.000	2.0	3.5
Dissolved Oxygen,	51.500	10.200	.700	.....	.....
Total Iron, .....	.....	.....	.700	.....	.....

In the sewerage decree of October 7th, 1907, issued by the Commissioner of Health to the borough of Kane, the following discussion may be found:

"A sanitary survey by the Department disclosed the existence within the borough of one hundred and thirty-six nuisances resulting from the improper disposal of sewage and kitchen drainage and these are scattered at different points, both in the sewered and the unsewered portions of the town. There are many estates abutting sewers that have not been connected therewith. In the interests of public health the local authorities should either compel the connection of every estate with the abutting sewer or enforce measures to secure a sanitary method of disposal of domestic wastes thereon. Cesspools should be abandoned and privy vaults, if used, should be made of masonry water-tight and carried up above the surface of the ground to keep out all surface drainage, and the local health board should see to it that these receptacles are cleaned out before they become full.

"The disposal of kitchen drainage into street gutters is a public menace, more especially during the presence of an epidemic. Health precautions demand that such drainage be conducted to the sewer. A plentiful supply of lime or some other disinfectant should be used along the street gutters until a permanent remedy be afforded.

"The Board of Health should cause an abandonment of all wells and springs in the borough so located as to be liable to surface or underground pollution. Failure to take this precaution at Ridgway, Elk County, has undoubtedly contributed to the extent of typhoid fever there. At present there are over two hundred and sixty cases under treatment, attributable to polluted water supply.

"It appears that the borough of Kane has extended its sewers during the years nineteen hundred and five and nineteen hundred and six, and during the current year, in defiance of State law and under the advice, so it is reported, of some of its officers. This policy was most ill-advised and extravagant. The sewers which have been built are much larger than necessary to carry off sewage proper and much too small to remove sewage and roof and street water. The discharge of sewage into natural water courses in Pennsylvania has resulted in so much sickness and death that the interests of the public health have demanded the enactment of a law to obviate such pollution. It is the policy of the Commonwealth to ultimately remove from all streams all domestic sewage and to require the treatment thereof before the liquid be permitted to go into natural water courses. The cost of treating both sewage and storm water is prohibitive and both economy and efficiency dictate that separate pipes shall be provided in many cases for the removal of the sewage. The sewers in Kane borough now receive large quantities of roof water, and the treatment of this storm water would make necessary a much larger expenditure, not only for the cost of erecting works big enough to receive and handle both sewage and storm water, but also thereafter for the operation of such unnecessarily large works.

"The existing sewers have been largely built by piecemeal, without due regard to the ultimate treatment of the flow or of the amount of flow which would be admitted to the pipe. At this time it is essential that the borough should study the entire question and lay out a comprehensive sewerage system and sewage disposal works, not only for the present needs, but also adapted to the growing and future demands of the town.

"Surface drainage facilities are naturally good. The slopes of the borough are adequate to afford speedy drainage, and surface waters now reach natural water courses in short distances and by them are conducted to the main streams. Short lines of storm drains may be built from time to time to perfect this system so that the problem of how to handle storm water is easy of solution. It is not necessary, in many cases, to conduct roof water to the sewers. The roof pipes may be led to the street gutters and the water be thus disposed of at the least cost. This method prevails and is satisfactory in communities several times the size of Kane. If this were done, sewage only would remain to be conveyed in the sewer pipes to the disposal works, hence the size of the works would be proportionately reduced and the cost of purification kept down to the minimum.

"It does not follow, because sewage is now discharged into the Kinzua and Tionesta Creeks, that this disposition is proper, or that the public health demands that the pollutions shall be increased. To the contrary, while it is evident that sewer extensions are needed in the borough, the petitioners fail to show why it is necessary that the health of the people owning property along the streams and whose stock drink from the waters outside of the limits of the borough should be endangered by a continuation of the pollution of these waters. The borough's assessed valuation is reported to be one million nine hundred and twenty-four thousand, four hundred and twenty dollars, and its bonded debt fifty thousand, five hundred dollars. If these figures are correct, the municipal borrowing capacity is in the neighborhood of eighty-four thousand dollars, a sum much greater than is necessary to defray the cost of treatment of the sewage before it is discharged into the waters of the creek.

"Owing to the very unsanitary conditions in the unsewered districts and the immediate benefits that will accrue from the extensions of existing sewers, and because the railroad depot cesspool should be abandoned and the new hotel on Fraley Street in the vicinity, cannot be opened without an extension to the existing system, and in view of the other circumstances, it seems desirable that sewers should be built at once."

At Stoneham the Elk Tanning Company has erected a plant for the treatment of the tannery wastes. At the Warren Water Works Filtration plant there is a small sewage disposal works.

(c) *Typhoid Fever.* The typhoid fever cases reported by the local health authorities of the boroughs of Kane and Mt. Jewett, from 1906 to 1912, inclusive, are given in the following table:

Typhoid Fever Cases Reported for this Section.

Town.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
Kane,	12	23	23	2	13	12	0
Mt. Jewett,	0	0	0	1	0	0	1

Section 6.—Conewango Creek to Brokenstraw Creek.

(a) *Along Allegheny River.* From Warren the Allegheny River flows in an almost due westerly direction for about eight miles when it is joined by Big Brokenstraw Creek. Below the Conewango, the river at ordinary stages is about 500 feet wide, the pools ranging in depth from six to ten feet, and the rocks which have fallen from the hills gradually increase in number and size, in the channel and along the shores. The valley averages about one mile in width with high rolling hills on either side. To the north of the river there are many oil wells and the flats in the valley and some of the uplands are farmed. The hills on the south bank of the river are precipitous, most of them covered with a second growth of timber. The average slope of the river in this portion of its length is 3.5 feet in a mile.

The total population of this section is 12,690 as follows: urban, 11,000; rural, 1,690. Warren with a population of 11,000 is the only municipality of any size in this section of the watershed.

The only railroads are the New York Central and the Pennsylvania, parallel lines, both following down the north bank of the river from Warren. There are no water power developments, the river is not navigable.

The chief and practically only source of sewage pollution is at Warren where the sewage of about 8,000 persons reaches the river by way of the borough sewers. While the industries are numerous and varied in character, it would appear that the principal sources of manufactural wastes which would noticeably affect the character of the water are the oil refineries, of which there are five at Warren. The exact extent of this pollution is not known to the Department at

the present time. The chemical plant at Struthers, above Warren, noted under Section 5, is the last plant of this character on the river proper as one proceeds down the stream, and there are no tanneries in this division or below it except those on the main tributary streams.

Warren is an incorporated borough with a population of 11,000 situated on the Allegheny at the mouth of Conewango Creek, the river and creek dividing the town into three portions. Beside being a railroad centre of considerable importance, it has many industries of varied character, the most important of them identified with oil production. There are five oil refineries, an acid works, three furniture factories, a foundry, machine shops, boiler shops, and tank works. The Elk Tannery and the Keystone Glue Works at Glade and the A. B. Smith & Co. chemical works at Struthers are intimately associated with the industrial life at Warren, but are above the town and have been previously described. The water supply of Warren has been derived from wells along the river and chiefly from Morrison Run, a stream tributary to Dutchmans Run, which enters the river from the south a short distance above the borough. On March 15th, 1907, the Warren Water Company, which furnishes the water to the public, received a permit from the Commissioner of Health for the use of driven wells, requiring purification of this source and of the Morrison Run supply or the abandonment of the latter, but permitting their use unfiltered in great emergencies and under certain conditions. On June 29th, 1908, a subsequent permit was issued in accordance with which a pumping station and a filtration plant consisting of settling tank and mechanical filters were erected above the borough near Glade Run bridge at a point where the Morrison Run supply line crosses the river. The Morrison Run supply is now filtered and an intake is constructed to permit the use of filtered river water at such times as the regular source becomes inadequate. The former pumping station and driven wells were abandoned. The necessity for changes and improvements in the water supply was brought vividly before the public by two epidemics of bowel trouble occurring in 1906. For three days beginning April 14th in that year, a rather mild epidemic of 400 cases was attributed, on investigation, to oil well and sewage pollution, or both, of the Morrison Run supply. From December 7th to December 12th, 1906, an epidemic of gastroenteritis occurred, numbering over 1,800 cases, most of which were in the part of town supplied with ground water. Special investigations by the Department indicated a sudden contamination of the supply by sewage traced to a leaky sewer in close proximity to wells of the water company, which suddenly developed leaks caused by repairs and alterations made a few hours previous to the rise of the river, flooded the wells and forced the escaping sewage into them in sufficient quantities thoroughly to impregnate the

supply with virulent infection. The borough has an extensive system of sewers serving some 8,000 persons. Two permits have been issued by the Commissioner of Health; one on September 29th, 1905, allowing certain extensions and granting temporary discharge of sewage into the river, but requiring preparation forthwith, of plans for a main intercepting sewer to be adapted to ultimate sewage purification. A second permit issued on March 23rd, 1907, approving certain extensions, gave permission to discharge sewage into the river from a proposed intercepting sewer until April 1st, 1909, the time then to be extended if the interests of the public health so demand. The sewers of Warren are for the greater part, combined sewers, but the permits issued for extensions have in view the ultimate separation of storm drainage and sewage. Many of the manufacturing plants have private outlets into Conewango Creek and the river for their manufacturing wastes.

(b) *Conewango Creek Drainage Area.* Conewango Creek rises in two small branches in the northwestern part of Cattaraugus County, New York and the northeastern part of Chautauqua County, New York. From the junction of these branches in Cattaraugus County, the creek flows in a southerly direction into Chautauqua County only to return again after a five-mile flow; the creek then turns again to the west and for a second time passes into Chautauqua County, flowing in a southerly direction across the Pennsylvania line into the western part of Warren County and forms a confluence with the Allegheny River at Warren, twelve miles south of the point at which it enters Pennsylvania.

The main tributary in New York State is Cassadaga Creek. This stream rises in Bear Lake about five miles from Lake Erie and flows in a southeasterly direction joining Conewango Creek about five miles north of the Pennsylvania line. Cassadaga Creek flows through a wide, flat valley almost its entire length. The country at its headwaters is a farming district, but lower down it is partly wooded while the broad valley at its mouth is excellent farming land.

Chautauqua Lake drains into Cassadaga Creek through Chadakoin River which is about seventy-five feet wide at its mouth. At the southern end of Chautauqua Lake the country is exceedingly flat for about a mile and a half on either side of the lake; and on these lands numerous summer cottages have been built. To the east and west of these flats there is a rolling farming country which slopes toward the lake. Above the narrow portion of the lake, the farms are fewer and the woodlands increase, especially on the north shore, which is about two-thirds wooded. Jackson Run is the largest tributary of the Conewango in Pennsylvania. It rises in the north central part of Warren County and flows in a southeasterly direction joining the Conewango two miles north of Warren. The headwaters of the Cone-

wango flow through narrow valleys with gently rolling farm lands and thinly settled waste lands on either side. Below Clear Creek there are wide plains to the east and low rolling hills to the west. After the creek enters Pennsylvania the valley widens with rolling hills to either side. For nearly twenty miles Conewango Creek parallels the Allegheny River flowing but a few miles west of it.

Conewango Creek is a slow, sluggish, winding stream, its fall not averaging over five feet to the mile. Although its descent is not rapid it has a continuous, never-failing supply of water which gives it considerable value as a source of power. The numerous water power privileges along its course were utilized by the early settlers and have aided materially in developing the resources of the country by furnishing the power for sawmills, carding machines, etc. For these reasons it was made a public highway from its mouth to the New York State line.

About 1790 the first settlement was made on the Conewango Creek. The valley of the Conewango was at this time largely covered with fine pine trees and the first class facilities for lumbering attracted the attention of lumbermen over a hundred years ago. The adaptability of the fertile, easily worked soil in this region was taken advantage of by the dairymen and fruit growers while the pines were disappearing beneath the woodman's axe, and soon many places were cleared for cultivation, not only in the valleys, but upon the table lands and the slopes between them. Since that time farming interests have been paramount to all others in this section and thirty years ago this was the most densely populated and best agricultural portion of Warren County.

Conewango Creek drains the oil fields of north Warren County. The pioneer well of these fields is located at Glade on the east side of this creek and was completed early in 1875. Warren, the point where the Conewango Creek joins the Allegheny River is 192 miles from the mouth and 116 miles from the source of the Allegheny. Conewango Creek drains an area of 935 square miles of which about 798 are in New York State.

The total population of the basin is 73,110, divided as follows:

	New York.	Pennsylvania.
Urban,	41,370	3,500
Rural,	25,520	2,720

The rural population is approximately thirty to the square mile.

The rainfall data taken at Warren cover a period of twenty-four years of which the records are complete for twenty-one years. The average annual precipitation in inches follows: maximum, 58.22; minimum, 32.54; mean for the entire twenty-four years, 43.12.

There are no cities of importance situated on the shed in Pennsylvania. Jamestown, New York, with a population of 26,000, and Chautauqua, New York, with a population of 9,000, are by far the largest places in the basin.

The precise extent to which water power is used is not accurately known by the Department, but the Chadakoin River, the outlet of Chautauqua Lake, has a considerable fall which is utilized by one or more installations at both Jamestown and Falconer. There are also two water power plants near the mouth of the creek at Warren, one furnishing 35 H. P. and operating the plant of the Bashlin Valve Company. The Conewango watershed in New York State is given over very largely to farming and grazing, while the industrial plants are principally occupied with the manufacture of furniture. In Pennsylvania also, agriculture is the dominant industry, but considerable oil is produced in the lower portion of the basin of the watershed near Warren.

Although the area is large, it is well equipped with railroad facilities. A branch of the New York Central extends from Warren along Conewango Creek and Cassadaga Creek to its head waters. A branch of the Erie extends from Jamestown along the north shore of Chautauqua Lake with a branch from Mayville to Chautauqua. The Pennsylvania & Southwestern extends from Jamestown in a northeastern direction to Buffalo following Conewango Creek to its source, and the main line of the Erie passes through Jamestown extending generally east and west across the watershed. The aggregate of these railroads is 192 miles.

Domestic water supplies throughout this territory are derived from wells and springs. So far as the Department is informed the principal streams are not used unless exception be made of the supply derived from the lake at the Chautauqua Assembly Grounds which is not used for drinking purposes. The extent to which the water is used for industrial supplies has not been ascertained.

Chautauqua Lake is clear generally, except that it is some times muddy in the vicinity of Mayville, and of good quality as it leaves the lake when it soon changes its character and becomes decidedly foul on the introduction of sewage and industrial wastes, especially at Jamestown and Falconer.

Domestic sewage is discharged into Conewango Creek or its tributaries by an urban and rural population estimated at 30,850 in New York State and 2,380 in Pennsylvania, making a total of 33,230 persons contributing sewage pollution to the stream out of a total population of 73,110. So far as known, the most important industrial wastes are those from the three worsted mills at Jamestown which employ about 2,000 operatives and the worsted mills at Falconer with 300 employees, the wastes consisting of spent dyes and wool scourings.

It is said that Cassadaga Creek has a minimum flow of eighteen cubic feet a second and Conewango Creek at the junction with the Chadakoin River forty-two cubic feet a second. At Warren the minimum flow (September 28th, 1908), was estimated to be 145 cubic feet a second, or 0.16 second feet to the square mile.

Cherry Creek, Chatauqua County, New York, is an incorporated village with a population of 630, of which some 350 persons contribute sewage to Conewango Creek near whose head waters the town is situated.

Randolph, Cattaraugus County, New York, is an incorporated village with a population of 1,160. It is situated about three miles from Conewango Creek on a tributary entering from the east. While there is no sewer system in the village, it is estimated that about 640 persons contribute sewage pollution.

Sinclairville, Chautauqua County, New York, with a population of 510 is situated on a small tributary of Cassadaga Creek a short distance from that stream. The polluting population is estimated at 280.

Mayville, Chautauqua County, New York, population 1,020, is the county seat and is situated at the head of Chautauqua Lake. It has a public water supply derived from shallow wells near the lake front, the quality of which is questionable. The village has no sewer system and cesspools are in general use. Probably 560 persons contribute sewage.

At Point Chatauqua some four miles from the head of Chautauqua Lake and on its west shore, are located the Chautauqua Association Grounds with an average population during the summer of from 6,000 to 7,000 persons, the attendance occasionally being as high as 12,000. The Assembly Grounds have two systems of water supply, one used for drinking water only and derived from four artesian wells which yield from 10,000 to 20,000 gallons daily and the other used for all other purposes, water being pumped from Chautauqua Lake to the extent of about 600,000 gallons daily. The grounds are provided with a comprehensive, separate sewer system and a disposal plant in which the sewage receives chemical treatment. Lime and occasionally alum are used. This plant serves the entire population with the exception of the men's club, from which the sewage is discharged into the lake about 1,300 feet below the water works intake.

Lakewood, Chautauqua County, New York, is an incorporated village on Chautauqua Lake about four miles from its outlet with a population of 550, about 390 causing sewage pollution. A few of the houses have private sewers, but there is no comprehensive system and the matter of sewage disposal has not been taken up with the New York Department of Health.

Celoron, Chautauqua County, New York, is an incorporated village with a population of about 700, situated at the outlet end of Chautauqua Lake. The village has one public sewer and a small, inadequate system of private sewers. On October 10th, 1906, the New York Commissioner of Health granted a permit for the discharge of sewage into the outlet of Chautauqua Lake for a period of one year and requiring that plans for an adequate system of sewers, including disposal works, be prepared and submitted to the New York Department of Health.

Jamestown, New York, a city with a population of 26,160, is situated in the southeastern part of Chautauqua County on the Chadakoin River. This river forms the outlet of Chautauqua Lake, Jamestown being situated about three miles from the lake. The industries of Jamestown are quite extensive and mostly concerned in the manufacture of furniture. There are three worsted mills employing about 2,000 operatives and water power is developed here to some extent. Jamestown has a municipal water works system. The city contributes the sewage of about 26,000 persons collected into one main sewer thirty inches in diameter, which carries the sewage to a point below Falconer, where it discharges into the river not far from its junction with Cassadaga Creek. The worsted mills at Jamestown discharge their wastes, including dyes and wool scourings, untreated, into the river.

Falconer, Chautauqua County, New York, with a population of 1,640, is an incorporated village lying just below Jamestown on the Chadakoin River. It is a manufacturing town including, among its industries, a worsted mill with about 300 employees. Water is supplied to the public by the Jamestown City Water Works. Electric power and light are furnished from a water power installation on the river at this point. The village has no general system of sewers, but on October 10th, 1906, the New York State Commissioner of Health issued a permit for the temporary discharge into the river of sewage from a small public sewer and requiring preparation of plans for a general system of sewers and sewage disposal works. About 1,200 persons contribute sewage and the worsted mill discharges wastes from the dye rooms and scourings from the wool into the stream.

Sugar Grove, Warren County, is a borough with a population of 600 situated near the head waters of Still Water Creek, a short distance south of the State boundary line. This stream flows in a northeasterly direction into New York State, entering Conewango Creek about five miles north of the State line. Its industries include the Sugar Grove Canning & Preserving Factory, which employ from eighty to ninety persons during the season, a planing and saw mill with sixty-eight employees and a creamery. There is no public water system and the inhabitants depend upon some thirty-five drilled and

driven wells and about the same number of dug wells. There is no public sewer system and but few private sewers and two or three cesspools, while kitchen wastes are largely discharged on the ground. About 210 persons contribute sewage pollution.

The Warren State Hospital for the Insane with about 1,500 inmates and officials is situated on the banks of Conewango Creek in Conewango township north of the borough of Warren. Its water supply is derived from two driven wells on the banks of Conewango Creek about 250 feet therefrom, from which the water is pumped to two reservoirs with a total capacity of 1,260,000 gallons, and thence distributed by gravity. The daily consumption is said to average 500,000 gallons in summer and 380,000 gallons in winter. Sewage is discharged from the institution by way of two outlets into Conewango Creek. On March 23rd, 1907, the Commission of Health issued a decree recommending the appropriation by the State of the necessary funds to install sewage disposal works. The work was in progress when this report was written.

In Table 34 are given chemical analyses of the Conewango Creek water at Warren.

TABLE XXXIV.
Chemical Analyses of the Conewango Creek Water at Warren.

Determination.	Jan. 25, 1907.	Oct. 3, 1907.	Oct. 4, 1907.	Oct. 6, 1907.	Oct. 6, 1907.	Oct. 7, 1907.	Oct. 7, 1907.
Appearance,	Slight.	Clear.	Color.	Color.	Color.	Color.	Color.
Turbidity,	None.	None.	None.	Distinct.	Slight.	None.	None.
Odor,	None.	None.	.15	.....	.....	Distinct.	Distinct.
Color,	40	30	.....	.....	50	40	40
Aluminum Ammonia, .....	.155	.270	.480	.410	.365	.450	.375
Free Ammonia, .....	.110	.075	.080	.065	.130	.070	.060
Nitrites, .....	.001	.....	.020	.200	.001	.0006	.001
Nitrates, .....	.500	5.000	10.000	4.000	Trace.	.3	Trace.
Chlorine,	3.000	5.000	10.500	7.150	7.60	4.0	4.0
Oxygen Absorbed,	3.400	5.000	10.500	7.150	7.45	4.0	6.0
Total Solids,	103.0	135.000	200.000	180.000	120.00	210.0	155.0
Iron, .....	.150	135.370	3.000	1.000	.50	.25	3.5
Alkalinity,	31.000	70.0	100.000	50.000	50.0	150.	70.0
Permanganent Hardness,	15.0	72.0	None.	None.	None.	None.	None.
Sulphuric Acid,	11.5	10.0	8.0	4.0	8.0	8.0	6.0
Carbonic Acid,	9.0	2.0	6.0	4.0	6.0	6.0	5.0
Dissolved Oxygen, .....	.....	.....	45.3	60.750	53.5	60.9	57.5
Aluminum,	1.0	.....	.....	.....	.....	.....	.....
Calcium,	21.2	.....	.....	.....	.....	.....	.....
Magnesium,	5.3	.....	.....	.....	.....	.....	.....

The Conewango and its tributaries have been stocked by the State Fish Commission with trout, bass, yellow perch, and pike perch. The Commission has also stocked the Allegheny River at Warren with bass, yellow perch, pickerel and pike perch.

(c) *Typhoid Fever.* In the following table is given a list of the typhoid fever cases reported for the years 1906 to 1912, inclusive, by the local health authorities of the boroughs of Warren and Sugar Grove. The Warren cases include those treated at the hospital, a number of which were brought in from the surrounding country.

Typhoid Fever Cases Reported for this Section.

Town.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
Warren,	31	33	42	33	31	10	13
Sugar Grove,	0	0	0	0	0	2	0

Section 7.—Brokenstraw Creek to Tionesta Creek.

(a) *Along Allegheny River.* From Big Brokenstraw Creek, the Allegheny flows in a general west of south direction for a distance of thirty miles, to where it is joined by Tionesta Creek. Throughout this distance the river averages 500 feet in width and the rocks and boulders which have fallen from the hills or have been pushed out by the tributaries gradually increase in size and number in the channel and along the banks. The average slope of the river during this section of its course is 3.5 feet to the mile. The lowlands adjacent to the river have been cleared for cultivation but the series of knobs and ravines on either side contain much timber. Near Hickory, on the east bank of the river, there remains a large tract of virgin white pine. Through this part of its course the river winds its way along alternate bluffs and narrow strips of flat low lands. Below Big Brokenstraw Creek the hills converge on the river banks and follow the stream quite closely as far as Red Bank Creek, leaving only occasionally any regular bottom lands. At Tionesta the stream broadens to twice its previous width as it swings toward the west. There are many islands in the river above Tionesta, as a rule wooded but sometimes cleared for farming. The total population of this section of the Allegheny River basin is 7,000, divided as follows: urban, 2,150; rural, 4,850. The only tannery along this stretch is situated on the river at Hickory in the northwestern part of Forest County. Tidioute is the only town having a population of over 1,000.

The tributary streams have been stocked with trout and the river with yellow perch, pickerel, pike perch and bass.

During the early days of the oil excitement keel boats and rafts were used on this portion of the river to some extent for the transportation of oil in barrels, but the practice was expensive and uncertain and with increased railroad facilities was entirely abandoned.

Industrially this section is essentially an oil producer, though farming is gradually resuming its former importance. A tract of virgin timber, mainly white pine, in the vicinity of Hickory Creek in Forest County is a very valuable asset, being probably the finest of the few remaining tracts of white pine in the State. A large saw mill on Hickory Creek is working up this timber.

The Pennsylvania Railroad follows the west bank of the river throughout for a distance of about thirty miles, the only other railroad being the Hickory Valley Railroad, essentially a lumber road, extending eastward up Hickory Creek and over the divide to the Tionesta Valley, where it joins the Tionesta and Sheffield Road.

There are two public water supplies, the Tidioute Water Company supplying Tidioute with water from Tidioute Creek, and the Tionesta Water Supply Company supplying Tionesta with spring water. Both systems are in very general use. So far as known, there are no industrial supplies.

A discharge measurement of the Allegheny River at Tionesta above the mouth of Tionesta Creek was made by the Water Supply Commission on September 28th, 1908, at a very low stage, which gave a minimum flow of 374 cubic feet a second. The tributary watershed at this point is 3,790 square miles, giving a minimum discharge of approximately one-tenth second feet to the square mile.

Tionesta and Tidioute, the only boroughs and the only towns of importance, both have sewer systems serving in all about 295 persons. The only industrial wastes of importance appear to be the surface washings and waste oil coming from the numerous oil wells.

Tidioute is an incorporated borough of about 1,300 inhabitants, situated on the west side of the river and extending for about a mile and a half along its banks. During the oil excitement it was much larger and an important centre; but for many years its population has remained practically stationary. Its industries comprise machine shops, cutlery, chair, furniture, and hub works. While wells and springs are used to some extent, the population is largely furnished by the Tidioute Water Company, deriving its supply from a wooded and practically uninhabited watershed at the head waters of Tidioute Creek north of the borough. It is reported that there has been no typhoid fever in the borough in twenty years except a few imported cases. There are a few small, public sewers, and a

number of private ones, serving perhaps 170 persons. There are many privies and a few cesspools, and kitchen waste is generally discharged upon the ground. There are no manufactural wastes of importance.

Tionesta, with a population of 850, the county seat and only borough in Forest County, is situated on the east side of the river at the mouth of Tionesta Creek, mainly on the low lands. Water is furnished by the Tionesta Water Supply Company, from three springs of excellent quality. The system is in very general use. It comprises a storage reservoir of about 60,000 gallons capacity, and a distributing reservoir on the brow of the hill within the borough limits. A few wells are in use. In 1906 there were nine cases of typhoid fever said to have been imported. Tionesta has a public sanitary sewer system aggregating about 12,700 feet, (six inch and four inch pipe) and two twenty-four inch storm sewers 900 feet in total length. Public sewer outlets are eleven in number and, with some six private sewer outlets, discharge either into the river or Tionesta Creek, chiefly the former, and the greater part of the population is served thereby. The industries consist of a casket hardware plant, tank factory, and a planing and two grist mills. There are no manufactural wastes of importance.

(b) *Brokenstraw Creek Drainage Area.* Big Brokenstraw Creek rises in the southwestern part of Chautauqua County, New York, on a high plateau and flows in a southwesterly direction across the Pennsylvania State line into Erie County, one mile west of the northwest boundary of Warren County. The stream here takes a general southerly direction into Warren County, passing through Columbus borough and then turns southeast to Garland, where it takes the form of a semi-circle and flows northeast for about eight miles. Here it changes its course and flows southeast to Irvinton, where it enters the Allegheny River.

The headwaters of Big Brokenstraw rise in a broad, well-farmed valley, the rounded hills surrounding it being covered with second growth hard woods and hemlock. On entering Warren County the creek flows through swamp land for a short distance, then through a wooded country with few farms and steep slopes to the south west. At Spring Creek the country is rolling and the valley widens until at Garland it is a mile wide. From here to Pittsfield the valley continues wide and flat but below Pittsfield the hills are more wooded and steeper and the valley narrows to a quarter of a mile at its mouth. Here the creek is about fifty feet wide and quite swift.

The most important tributary of Big Brokenstraw Creek is Little Brokenstraw Creek. This stream has its source in numerous rivulets rising in a broad tableland in Freehold township, Warren County. It flows through a wide valley that it partly farmed but contains much waste land and some second growth hemlock. At its mouth

the valley is about a mile wide, shallow and flat. The general direction of this branch is southeast from its source to the confluence with the main stream at Pittsfield about eight miles west of its junction with the Allegheny River.

Hare Creek rises in the southwestern part of Chautauqua County, and in the northwestern part of Wayne Township, Erie County, and flows in a general southeasterly direction through the city of Corry into Warren County, joining Big Brokenstraw Creek in the southwestern part of Warren County about two miles from the Erie County line. This creek flows through a broad, flat farming country throughout its length.

Big Brokenstraw Creek is an important feeder of the Allegheny River. It has a very persistent flow in periods of drought and is perhaps in this respect the most remarkable of any tributary of the Allegheny River. This is accounted for in a degree by the abundant supply of perennial springs in the cool, elevated region in which it rises. This stream flows through a fertile, rolling, farming country and is rather sluggish throughout its length. A gauging of this creek taken at Irvinton September 28th, 1908, shows the minimum discharge to be 45.17 second feet.

The broad valley of this stream was originally covered with superb pine groves and the ready facilities for rafting early attracted the attention of lumbermen; but in late years that industry has fallen off to a considerable extent, due to the enormous waste in cutting. In 1801 the first lumber was rafted from the Big Brokenstraw to Pittsburgh and in 1805, seasoned lumber was rafted to New Orleans. As the pines disappeared the adaptability of the easily-worked, fertile soil of the creek bottom and the smoothly contoured hills to the north became apparent to the agriculturist and many clearings for cultivation were made. Since then farming interests have taken precedence of all others in this district.

Good building stone is abundant and an ample supply of loose sandstone blocks can be found upon the surface. The rock most used is a massive coarse-grained yellow and white sandstone, sometimes stained with streaks of iron. It appears soft when fresh from the ledge but hardens upon exposure and is highly desirable if carefully selected as to color and composition. Just north of the junction of Spring Creek with Big Brokenstraw large morainal deposits are found. Above these the Brokenstraw valley is very broad with evidences of its once having been a lake bottom. Between Spring Creek and Garland some portions of the Brokenstraw valley are quite narrow and the hillsides steep and high.

Big Brokenstraw Creek drains an area of 300 square miles, including all of the northwestern part of Warren County. At Irvinton where Brokenstraw Creek joins the Allegheny River the distance to

the mouth of the river at Pittsburgh is 184 miles and to the source of the Allegheny, 124 miles. This creek has been declared a public highway from its mouth to the New York State line.

Rainfall records at Corry have been kept regularly for seven years and cover a total period of eight years. The maximum annual precipitation in inches is 65.66, minimum 36.43, and mean for the total period 46.48.

The total population of the basin is 18,950, divided as follows:

	New York.	Pennsylvania.
Urban,	380	9,400
Rural,	1,930	7,240

The rural population is approximately thirty to the square mile.

There are two tanneries on this basin, one on Hare Creek adjoining the city of Corry, and the other on Big Brokenstraw Creek at Spring Creek. The only towns of importance on the shed are Corry with a population of 7,500 and Youngstown with a population of 1,200. These are both growing little municipalities with good railroad facilities which with other inducements have brought to the boroughs, numerous planing mills and manufacturing plants.

The only water power installation noted on the stream or its tributaries is at Columbus on Big Brokenstraw Creek where 55 H. P. is developed. Farming and grazing is largely practised throughout the watershed and the principal industrial plants are the furniture factories at Corry and the tanneries at Corry and Spring Creek, the latter plants being operated by J. W. & A. P. Howard & Co., Ltd., manufacturing sole leather.

Branches of the Erie, Pennsylvania, and New York Central Railroads pass through the watershed. The Western division of the Pennsylvania follows the main stream from its mouth perhaps two-thirds of its length to Corry. The total length of railroad in this territory is about sixty miles. The creek and its principal tributaries are not used for public water supply except that Hare Creek is available for emergency purposes above Corry. The Howard Tanneries at Corry and Spring Creek use creek water for industrial purposes.

An analysis (August 17th, 1909), of the water of Hare Creek at the Howard tannery below the Corry sewer outlets shows sixty-three parts alkalinity in a million. It is estimated that a total population of 7,690 contributes sewage either directly or indirectly to the waters of Big Brokenstraw Creek. The only industrial wastes of especial importance come from the Howard tanneries at Corry and Spring Creek. These wastes amount to about 100,000 gallons a day in the Corry tannery and 50,000 gallons a day in the Spring Creek tannery and produce a marked effect on the quality and appearance of the

stream. An outbreak of anthrax among the cattle drinking of its waters and the nuisance caused by the noxious odors has resulted in a decree from the State Commissioner of Health ordering the construction of purification works for the treatment of these wastes and a plant has been installed for this purpose at the Corry tannery.

Panama, Chautauqua County, New York, is an incorporated village with a population of 380 situated in the southwestern part of the county at the head waters of Big Brokenstraw Creek about 5 miles north of the State boundary. It is estimated that about 200 persons contribute sewage to the waters of the creek.

Columbus, Warren County, is a borough with a population of about 400 in the northwestern part of the county on Big Brokenstraw Creek about three miles from the western boundary at Corry. The industries are limited to a creamery, saw mill, and flour mill. The water supply is derived from private dug and drilled wells. There is no sewerage system and kitchen waste is discharged on to the ground. It is estimated that about 100 persons contribute sewage pollution. Water power installation here develops 55 H. P.

Corry, population 7,500, is a city in the extreme eastern part of Erie County on the divide between French Creek and Big Brokenstraw Creek, its drainage being principally to the latter stream. It is a prosperous, industrial community with three railroads, the Erie Railroad and the Western and Chautauqua divisions of the Pennsylvania Railroad. There are some thirty industries, the most important being the locomotive works of the Climax Manufacturing Company, the U. S. Radiator & Boiler Company, the Ajax Iron Works, the Corry Condensed Milk Company, Corry Chair Company, McInness Steel Company, and the U. S. Chair Company. A large tannery of J. W. and A. P. Howard & Co., Ltd., is located just east of the city in Warren County. Public water is supplied by the Corry Water Company from four driven wells about fifty feet in depth, and an emergency connection to Hare Creek. The per capita consumption for domestic use is said to be sixty gallons a day. The city has a combined sewer system aggregating about twelve miles, discharging into Hare Creek by way of a forty-eight inch and a thirty-six inch outlet. On September 15th, 1908, the Commissioner of Health issued a permit to the city of Corry for the construction of certain sewers and the discharge of sewage therefrom into Hare Creek and requiring that plans for a comprehensive sewerage system and disposal works be prepared and submitted to the Department. The wastes from the industrial plants in the city are not of special importance, the greatest pollutions being the sewage from the city and the wastes from the Howard tannery. The Howard tannery has a capacity of about 150 hides a day using both green and dry hides. Extract is used in the tanning process and lime for dehairing. Sulphuric and

acetic acid are also used, the spent acids being neutralized by the waste lime. The waste liquors amount to about 100,000 gallons a day, this amount being discharged in ten hours, containing hair, fleshings manure, lime (slight), and a trace of tannic acid, which gives the dark color to the effluent. In the summer of 1907 an outbreak of anthrax among cattle drinking the waters of Hare Creek was attributed to the tannery waste pollution. The Department made a special investigation resulting in an order to the tanning company to cease the pollution of the stream and to prepare plans for purification works for the treatment of the tannery's sewage and wastes. Plans were approved by the Commissioner of Health on September 16th, 1908, and the plant has been constructed. The decree of September 16th, 1908, also contained the requirement that the wastes from the Spring Creek tannery of the same company situated a few miles further down the stream be also purified. The Spring Creek tannery uses the same process as that in operation at Corry, the capacity and the wastes being about one-half as great and similar in character.

Bear Lake, Warren County, population 300, is a borough situated in the northwestern part of the county at the New York State boundary. The springs within the borough form the head waters of Little Brokenstraw Creek. No industries are noted and there is no public water system, the domestic supply being drawn from wells and four springs. There is no sewer system, the only sewers being small drains carrying kitchen waste to the highways or runs.

Youngsville, Warren County, is a borough with about 1,200 population situated on Big Brokenstraw Creek about three miles from its mouth. Its industries comprise two furniture factories, three planing mills and two brick yards. There is no public water system, the inhabitants using driven wells, of which there are about 300 in the borough. There is no public sewer system but from time to time private sewers have been built ranging in size from six to ten inches, having a total length of 6,000 feet, discharging sewage from about 380 persons to the creek. There are also in use about 250 earth privy vaults and about twenty cesspools, some of them in proximity to wells used for drinking purposes. A permit was granted by the Commissioner of Health October 11th, 1906, for the construction of a ten-inch sewer discharging into the creek and requiring that plans for a comprehensive sewerage system and disposal works be prepared and submitted.

In the permit issued to Corry city by the Commissioner of Health, March 14th, 1912, approving plans for a comprehensive system of sewers and sewage disposal works, the following discussion of the State's policy with respect to the pollution of the waters of the Brokenstraw Creek may be found.

"Hare Creek is notorious as a badly polluted stream. Not only is the discoloration noticeable from the passenger coaches of the Pennsylvania Railroad that parallels the stream for many miles, but the odors are apparent to passers on the nearest highway, especially in the summer time. The principal source of contamination is the tannery. The owners of the tannery are preparing to treat the waste liquid more thoroughly than is now accomplished with the object in view of destroying the anthrax germs found existing in the liquids by the State Department of Health, but no plan is proposed so far as the Department knows, to remove all the color from these manufacturing wastes. In consequence of the high color of the waters of Hare Creek, the ordinary uses of the stream through the rural district have been abandoned. This has lessened to some extent the danger that would otherwise exist by the discharge of the city sewage into the same stream. Nowhere along the Brokenstraw is the water used for domestic purposes under approval by the Commissioner of Health. To the contrary warning notices have been posted by the Department along the banks of the creek for miles and owners of abutting estates have received communications directly from the Commissioner apprising them of the dangers in the situation.

"The object of the sewage disposal hereinbefore described is to minimize the nuisance in Hare Creek so far as the city's sewage is a contributing factor. These works are not calculated to render the waters of Hare Creek suitable for the ordinary uses of which the riparian owner is possessed where the streams flowing through his lands are unpolluted. In this light and from the fact that mingled sewage and storm water is to flow into Hare Creek from the city's sewers according to the plans submitted, the plans are worthy of adoption. Furthermore, the local authorities have submitted convincing statements relative to the utter inability on the part of Corry city to expend at the present time any part of the sum requisite for the sewerage improvements offered in the plans. It is true that Corry is about the smallest city in Pennsylvania and one in which very liberal expenditures for public improvements have been made. When the existing combined sewer system was built, it was thought to be in accordance with the most up-to-date plan. The treatment of sewage was not then contemplated or required in Pennsylvania. Notwithstanding this situation and the fact that the municipal borrowing capacity is practically reached, the local authorities stand ready to meet the requirements of improved sanitation with regard to disposal of sewage, if sufficient time be given in which to work out the financial problem. There are a succession of steps possible in progress towards an ultimate high degree of purification of the city's sewage to which attention has been directed by these authorities.

"The first step might be to divert the flow from the existing forty-eight inch sewer into larger settling tanks and thence through the sterilization plant to the creek, and providing for the construction of the sludge filter, all to be operated by gravity. This would entail an expense for construction of twenty thousand dollars. In about three years from now the city will be in a position to assume this expense.

"The next step might be the construction of storm relief as outlined, at an estimated cost of forty thousand dollars, which would reduce the amount of sewage to be treated at the plant more than a million gallons per twenty-four hours. The third step might be the construction of the outfall sewers for the gravity districts as explained, and the building of the contact beds. The outfall sewers would involve an expenditure of twenty-five thousand dollars including the sewage lift. The contact beds, are estimated to cost thirty thousand dollars. It may be that when the time comes to consider the erection of the filters a different type may be found more efficient and economical, or necessary.

The city should proceed to construct all lateral extensions from now on as sanitary sewers only, in conformity with the general plans and with the object of the ultimate collection in a sanitary sewer system of all of the sewage of the city and in its complete purification at the disposal works. Furthermore, the city should acquire at once the land at the site proposed for sewage disposal."

The permit of 1906 issued to the borough of Youngsville contained the following discussion of the State's policy relative to stream pollution for the lower Brokenstraw Creek valley.

"A prominent citizen of the borough has recently erected a primary, an intermediate and a high school building and presented them free to the municipality as a memorial. These buildings are on the east side at the corner of College and Bates Streets. They have been fitted with modern plumbing facilities and no other method of disposing of the sewage than by a sewer has been contemplated or provided. The borough purposes to construct a ten inch sewer northerly in Bates Street a distance of twenty-three hundred feet to the creek, and discharge said sewage therein below low water. Manholes are to be provided at street intersections, at changes in line and grade, and not over greater distances than five hundred feet apart. It is intended that this sewer shall be one of the submains of a system of sewers for the entire borough and a reconnaissance survey has been made by the engineer for this purpose which has been used as a basis for the design of the proposed sewer.

The borough of Siverly takes a portion of its water supply from the Allegheny River and Oil City has an emergency intake therein. Emlenton borough, Parkers Landing and Foxburg are reported as taking their water supplies from the Allegheny River. The nearest one of these places is fifty-one miles below Youngsville. The last two places are one hundred miles below. Only considerations of great importance should be weighty enough to admit of the discharge of sewage into Brokenstraw Creek under the circumstances. It is to be regretted that the borough authorities should have waited until the school buildings are ready for occupancy before having applied for permission to build a sewer; but this is explained by the fact that the authorities were not aware of the statutory provisions. Refusal to grant temporary permission to use the proposed sewer would prevent the schools being opened. The construction of loose cesspools would pollute the wells, not only on the school property, but in the entire vicinity. The construction of a water-tight masonry vault would entail a prohibitory expense, and the authorities do not know how they could dispose of the liquids when they should be pumped out. An enrollment of three hundred and fifty students is anticipated.

"Since the borough of Warren at present discharges its sewage into the Allegheny River under temporary permission by the State Health Commission pending the preparation of plans for sewage purification works, and Oil City is permitted to do the same, it would appear that the demand on the score of public health may permit the temporary discharge of the proposed sewer in Youngsville into Brokenstraw Creek."

The lower branches of Brokenstraw Creek have been stocked by the State Fish Commission with bass and pickerel. A number of the tributaries have been stocked with trout.

(c) *Typhoid Fever.*

Typhoid Fever Cases Reported for the Section of the Allegheny Basin from Brokenstraw Creek to Tionesta Creek, 1906—1912, inclusive.

Town.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
Tionesta,	9	0	1	0	0	1	1
Tidioute,	0	0	0	0	2	0	0
Columbus,	0	0	0	0	0	1	0
Corry,	1	10	2	1	1	1	3
Bear Lake,	0	0	0	1	0	0	0
Youngsville,	0	0	0	1	9	2	2

Section 8.—Tionesta Creek to Oil Creek.

(a) *Along Allegheny River.* From the mouth of Tionesta Creek the Allegheny River flows in a general westerly direction, in a circuitous course, for a distance of twenty miles to the central part of Venango County, where it is joined by Oil Creek. During this part of its course the river flows through a narrow valley bordered with rocky bluffs. On the south side of the river the country is terraced and farmed and on the north bank where the hills are less steep most of the slopes are farmed. Over this part of its course the average slope of the river is three feet in a mile. Pithole Creek, the largest tributary, drains the northeastern part of Venango County and flows in a southerly direction joining the Allegheny River near Oleopolis. This stream is about twenty feet wide at its mouth and flows through a narrow valley bordered by steep hills which are frequently broken

by ravines. A minimum discharge gauging of the river at Tionesta on September 28th, 1908, gave 374.65 second feet. The total population of this section of the Allegheny Basin is 5,610, divided as follows: urban, 2,100; rural, 3,510. Siverly, the largest town, has 1,400 population.

The tributaries of the river have been stocked with trout and the Allegheny River has been stocked with trout, bass, yellow perch, pickereel, and pike perch.

Industrial activity centres primarily around gas and oil production, nearly the entire district having produced heavily at one time or another. Farming, formerly paramount, was little practised during the oil craze, but with the diminishing supply of oil is again becoming important. The lumber industry is also in evidence with saw mills at Grandin, Oleopolis, and near Walnut Bend. There are many summer cottages scattered all along the shores and bluffs throughout this stretch of the river, and oil well derricks are found on every hand. The largest industrial plant is the Imperial Works of the Oil Well Supply Company at Siverly, employing 650 men in the manufacture of machinery used in the production of oil and gas. The only railroad is the Pennsylvania, which follows the north or west bank of the river throughout this part of its course, about twenty miles.

The Pittsburgh Testing Laboratory analyzed samples of the river water at Siverly and the State Department of Health made bacteriological tests of the river water at the same place.

TABLE XXXV.—Bacterial and Chemical Analyses of River Water at Siverly.

Determination.	Drilled Well in River.	River Water.
	Parts Per Million.	
	Aug., 1907.	Sept., 1904.
Silica,	10.0	18.9
Oxide of iron, .....	.....	.....
Carbonate of lime,	241.1	41
Carbonate of magnesia,	21.8	6.7
Sulphate of lime,	19.4	14.6
Sulphate of soda,	3.6	7.5
Sulphate of magnesia,	45.6	.....
Chloride of soda,	74.3	61.1
Nitrate of soda, .....	.....	.....
Incrusting solids, .....	.....	80.3
Non-incrusting solids, .....	.....	68.6

TABLE XXXV.—Bacterial and Chemical Analyses of River Water at Siverly.—
Continued

Date of Sample.	Bacteria per Cubic Centimeter.	
	Total.	B. Coll.
Dec. 7, 1907,.....	1,000	3
Jan. 7, 1908,.....	1,600	0
Feb. 7, 1908,.....	45	0
May 7, 1908,.....	700	0
Aug. 12, 1908,.....	300	0
Mar. 4, 1909,.....	350	10
May 6, 1909,.....	250	5
June 10, 1909,.....	760	0
July 9, 1909,.....	42	1
Aug. 12, 1909,.....	48	0

The domestic water supply of Pleasantville consists of private wells and springs and a new municipal system with drilled wells as the source. Siverly borough is supplied with water by the Siverly Water Company, whose plant consists of a so-called "Filtration well," sunk on a small island which is submerged for about ten months each year, a pumping station in the power house of the Oil Well Supply Company, and a distributing system, into which the water from the well is pumped and served to the consumers. The average consumption is said to be 200,000 gallons, of which about 196,000 gallons are used for industrial purposes. A spring also furnishes a part of the water.

One-fourth of the population of Pleasantville and practically all of Siverly contribute domestic sewage, about 1,930 persons polluting the stream in this way. Aside from wastes due to oil production, the most important industrial pollution is at Siverly, where the Oil Well Supply Company discharges, it is said, about three barrels a week of spent acid solutions from the galvanizing plant together with the oil drip from engine and machinery.

Pleasantville, an incorporated borough with a population of about 700 is situated at elevation 2,200 on the divide between Oil Creek and Pithole Creek, its drainage flowing chiefly to the latter stream. There are no industrial plants of importance, the chief interests being gas and oil and farming. Water for domestic purposes is obtained from about a hundred wells and eight or ten springs, all private. Of these perhaps forty are dug wells. Recently the borough officials have installed a public system deriving water from three driven wells. There are a few public sewers but only a dozen or so buildings are connected with them, privies and cesspools being in general use.* The extensive use of private dug wells in the vicinity of privies is a condition which menaces the health of the inhabitants, and there have been a few cases of typhoid fever from year to year; but the sanitary conditions would indicate that the borough has been fortunate in this respect. There are no manufactural wastes contributed by this borough.

On February 13th, 1912, the Commissioner of Health approved plans and specifications for sewage disposal works for Pleasantville. The system was built and in accordance with modified plans approved May 20th, 1912, and at the end of the year 1912 the works were in operation.

The borough of Siverly, on the west side of the Allegheny River adjoining Oil City, has a population of about 1,400 with the resident portion on the bluff and the business part on the lowlands along the river. The manufacturing interests comprise a celluloid works and the Imperial Plant of the Oil Well Supply Company, the latter being the dominant industry of the borough, with 650 employees engaged in the manufacture of gas and oil well tools and machinery. The water supply is furnished by the Kramer Water Company and the Siverly Water Company. The former derives its supply from a spring in the rocks on the hillside, and the Siverly Water Company, which is controlled by the Oil Well Supply Company, takes its supply from a well sunk in Elkhorn Island in the river. This island is low and said to be submerged for about ten months every year. The water of the river percolates through the sand and gravel soil into a perforated tile drain leading to the well and directly into the well itself. It is reported that about nine-tenths of the inhabitants use the water from this source. There are also a number of dug wells and some springs in use. Oil City maintains an emergency intake from the river on the opposite side from Siverly. There is no public sewer system, the sewage of the borough being disposed of principally in common privy vaults and cesspools, but there are some ten private sewers discharging sewage into several runs and the river within the limits of the borough. Six of these are small, ranging from four to eight inches in diameter. Four serve the works of the Oil Well Supply Company and range in diameter from ten to eighteen inches. A comprehensive plan for separate sewerage system is under consideration by the borough officials, contemplating ultimate disposal of sewage either separately or in conjunction with Oil City and West End borough. The only manufactural wastes of importance consist of about fifteen gallons a day of spent acids from the galvanizing plant of the Oil Well Supply Company.

In a decree relative to sewerage issued by the Commissioner of Health to the borough of Pleasantville in May, 1910, the following discussion of the State's policy in that vicinity may be found:

"Pithole Creek receives some sewage from individual houses and considerable pollution from oil well operations. The stream is nowhere in its course used as a source of public water supply. There is no town or village along its course but a settlement known as Pithole City where twenty-five people live. This is one of the streams of the Commonwealth not now polluted with sewage and there seems to be no reason why sewage should be discharged into it, especially since it is the policy of the Commonwealth to preserve the purity of the waters of the State. Running water has been introduced into the houses and becomes soiled by the wastes of the household and if the individual householder will be prudent in the use of water, the collection and disposal of it on his own estate may prove

the most economical and with proper attention a sanitary expedient. To build the sewers proposed in Pleasantville will cost a considerable sum of money. If the contributors are willing to erect a sewage disposal plant in connection with the sewers then the improvements should go on, but if the money is not forthcoming for the immediate erection of the purification plant then the sewer construction should not be undertaken.

"Some one experienced in the treatment of sewage should be employed to devise the plans for the plant. The Department will be glad to consult with the local authorities relative to this subject. The site proposed for the sewage works seems to be favorable, but whether it is the most economical one from all standpoints the Department is not ready to say at this time."

(b) *Tionesta Creek Drainage Area.* The headwaters of Tionesta Creek lie in three branches in the southeastern portion of Warren County, the southern central part of McKean County, and the northwestern corner of Elk County. The main branch rises in southeastern Warren County and flows northeast to Clarendon where it bends in an easy curve and flows southeast to Sheffield, where Two Mile Run joins it coming from the east. About two miles below this junction the East Branch joins the main stream, flowing in a southwesterly direction. From this junction the creek flows in an irregular course in a southerly direction and enters Forest County near its northeast corner. From this point the creek takes a general westerly direction through Howe Township, then turns and flows southwest through Kingsley and Green Townships and enters Tionesta Township, where it takes a general westerly direction to its confluence with the Allegheny River at Tionesta borough in the southwestern part of Forest County.

The Tionesta Creek flows through a broad, deep valley, joined by numerous steep tributary ravines. Its whole course is a very winding one and the highlands through which it flows are deeply carved. The tributaries of this stream flow swiftly to the narrow and more gently sloping valley of the Tionesta and drain a section containing many oil and gas wells.

The headwaters of the East Branch of Tionesta Creek rise in rolling hills and the country through which they flow is largely covered with a second growth of timber. Two Mile Run flows through a narrow valley. The hills on either side are steep and covered with a poor second growth while the country back from the hills is, to a great extent, a barren waste land. The creek above Ludlow is clear but below it is black, due to tannery wastes from Ludlow. Salmon Creek rises in the eastern part of Forest County, flows in a southwesterly direction for a few miles, then turns to the northwest and joins the Tionesta Creek about three miles below Kellettsville. This is a winding stream that flows through a barren waste country.

Near the headwaters of the Tionesta a high grade oil is found in the extensive Stoneham-Clarendon field. At Clarendon the valley is about one-half mile wide and consists of flat, swampy waste lands

covered with a scrub growth, but further down the stream the soil improves, good farms are numerous in the valley and the hills are wooded. Along the divide between the Tionesta Creek and Clarion River the country presents a wide waste; most of it has been cleared of timber and very few farms are located here. In the eastern part of Forest County on the east slope of the Tionesta valley between Cloughs and Watson there is a large tract of virgin hemlock but the country surrounding this tract has been cleared of timber and is at present a waste and barren land. Between Tionesta and Nebraska the valley is extremely narrow, affording many good sites for the development of water power. The Tionesta Creek has been used extensively for logging and the whole creek has been declared a public highway. The point of confluence of the Tionesta and the Allegheny River is midway between the source and the mouth of the Allegheny River.

The Tionesta Creek drains an area of 458 square miles, including nearly all of Forest County and parts of McKean, Warren and Elk Counties. This stream is badly polluted by tannery wastes from three tanneries at Sheffield, and by one each at Brookston, Ludlow, Clarendon and Kellettsville.

A gauging of this creek taken at Tionesta on September 28th, 1908, showed the minimum discharge to be 39.7 second feet. The mean annual rainfall in this region is between 40 and 45 inches.

The total population of the basin is 11,660, divided into the following proportions: urban, 4,200; rural, 7,460. The total rural population is approximately sixteen to the square mile.

There are but two towns in the basin with a population of over 1,000, namely, Sheffield, 2,500 and Clarendon, 1,100. The principal industry of both towns is tanning. In Sheffield there are two tanneries and one directly above the town on Two Mile Creek. There is some lumbering done near by and a glass plant in the village employs the inhabitants not engaged in tanning.

There is a 50 H. P. water power development at Nebraska, Forest County, on Tionesta Creek about six miles from its mouth and also a small development near the mouth of the stream at Tionesta.

The watershed of Tionesta Creek is well timbered and lumber operations are extensively carried on, the abundance of timber being also responsible for the establishment of numerous tanneries and chemical plants. The principal industrial plants are tanneries of the Elk Tanning Company at Clarendon, Sheffield, Brookston, and Kellettsville, and the J. G. Curtis Leather Company tannery at Ludlow. Chemical plants for the manufacture of wood alcohol are the Wetmore Chemical Company at Wetmore, the Nansen Chemical Company at Nansen, and a plant at Roystone.

The Sheffield Glass Bottle Company operates a glass plant at Sheffield and the American Plate Glass Company has a plant at James City. At Clarendon are the Levi Smith Oil Refinery, the John Goal Refinery and another oil refinery, and there is a refinery at Tiona.

Railroads traverse the watershed in all directions; but they are mostly narrow gauge lumber roads. The Sheffield & Tionesta and the Tionesta Valley roads follow the creek throughout the greater portion of its length. The Western division of the Pennsylvania crosses the basin near its head waters, and a branch of the Baltimore and Ohio follows the crest of the divide on the south for a distance of forty-six miles. The total trackage, including the Baltimore and Ohio on the divide, is about 165 miles.

At Clarendon, water for domestic uses is derived from wells and springs and an industrial supply for the Elk Tannery is taken from Tionesta Creek. At Sheffield the public water supply is derived from wells and springs and chiefly from Deer Lick Creek, the three tanneries and a glass plant having private industrial supplies from Tionesta Creek. The tanneries at Kellettsville and Brookston each have industrial supplies, the former from Tionesta Creek and the latter from Bogus Run, wells and springs. Domestic sewage is contributed either directly or indirectly to Tionesta Creek by an urban population of about 2,700. The industrial wastes discharged into the creek are very extensive, the most important coming from the tanneries and chemical plants, the character of which wastes has been discussed elsewhere. The waste waters discharged from the tanneries is estimated to be about 217,650 gallons a day. The chemical plant pollutions are extensive and the wastes from the oil refineries form a polluting factor of importance.

Clarendon, Warren County, is a borough with a population of 1,100 situated on Tionesta Creek about nine miles from its head waters. Its industries include three oil refineries, the Levi Smith Refinery, the John Goal Refinery and another, a tannery of the Elk Tanning Company and a lumber mill. Oil is also largely produced in the vicinity. A private company supplies water to the public, deriving its supply from a drilled well 171 feet deep within the borough. A reserve supply for fire purposes is derived from a spring on the mountain side near by. The Elk Tannery derives a private supply for industrial purposes from springs and from Tionesta Creek. A portion of the borough is served by public sewers, and there are also a number of private sewers in use discharging to the creek or to runs or a pond tributary to the creek and in some cases to the highways. Kitchen wastes generally are discharged on the ground or into the highway. The Levi Smith refinery employs from fifteen to twenty men, handling about 8,000 barrels crude oil each month. The wastes, which contain sulphuric acid, pass through a swamp some distance to Tionesta

Creek. A small pond within the borough has become a nuisance by reason of the discharge of refinery wastes. The Elk Tannery wastes consist of water from hide soaking, lime water, and bleach water. The waste tan liquors are shipped to Sheffield and Ridgway and reclaimed.

Sheffield Village, Warren County, population about 2,500 is situated in the southeastern part of the county on Tionesta Creek. Its dominant industry is tanning, there being three tanneries, the "Horton," the "Tionesta" and the "Sheffield," all belonging to the Elk Tanning Company, as well as the Sheffield Extract Works of the same company. There is also a plant of the Sheffield Glass Bottle Company near by and a large saw mill of the Central Pennsylvania Lumber Company. The tanneries employ the greater part of the population. The glass works have from 100 to 125 employees and turn out about three carloads of glass bottles a week. The saw mill is a new plant which will give employment to a large number of men. Water is supplied to the public and to a considerable extent for industrial purposes by the Sheffield Water Company, formerly known as the Deer Lick Water Company, whose supply is derived from Deer Lick Run and from drilled wells. This company supplies about two-thirds of the population. The Elk Tanning Company supplies a number of its own houses with water from wells and springs. Formerly the tanneries used the Sheffield Water Company's supply for industrial purposes resulting in an occasional shortage of water for domestic use, but this use has been discontinued and the supply seems adequate. The tanneries are supplied for industrial purposes with water from a private system of driven wells on Tionesta Creek. The glass works also has an industrial supply taken from the creek. It is estimated that about three-fifths of the population contribute sewage pollution, chiefly by way of numerous private sewers, although there is no public sewer system. There are no liquid wastes from the glass works or the extract works, but the tanneries discharge into the creek a large amount of objectionable waste water.

Ludlow, McKean County, is a village of 600 population situated on the boundary between Warren and McKean Counties on a tributary of Tionesta Creek. Industrially it depends upon the J. G. Curtis Leather Company's tannery which handles 800 green salt hides daily. Both extract and bark are used in the tanning process and lime is used for dehairing. Sulphuric acid and acetic acid are used at this plant.

Brookston, Forest County, population 500, is a village in the extreme northeastern part of the county on the south branch of Tionesta Creek. Industrially it is dependent upon a tannery of the Elk Tanning Company.

Waste tan liquors are reclaimed. The tanning company derives an industrial supply of water from Bogus Run and wells and springs.

Kellettville, Forest County, population 600, is situated in the central part of the county on Tionesta Creek. The village is dependent industrially upon the Elk Tanning Company's tannery, which derives an industrial supply from Tionesta Creek.

(c) *Typhoid Fever.* In the following table are given the number of typhoid fever cases reported to the State Department of Health by the local authorities of several important places in the section for the years 1906-1912, inclusive.

Typhoid Fever Cases Reported for the Section of the Allegheny Basin from Tionesta Creek to Oil Creek, 1906-1912, inclusive.

Town.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
Clarendon,	0	0	0	0	0	2	6
Ludlow,	0	0	0	0	0	0	45
Pleasantville,	0	0	4	1	1	0	2
Silverly,	0	2	1	2	0	0	6

Section 9.—Oil Creek to French Creek.

(a) *Along Allegheny River.* From Oil Creek the Allegheny River flows in a southwesterly direction for a distance of eight miles to Franklin City where it is joined by French Creek. The valley is about one mile wide, bordered by steep wooded banks and narrow ravines. Occasional farms are found on the gentle slopes where the country has been cleared of timber. Both the banks and the bed of the river are firm, though not generally rock. Below Oil City, heavy ice gorges are frequent, due to cold winters, rapid current, sudden floods and the number of its short bends. The slope of the river during this part of its course is three feet to the mile. Numerous oil derricks are scattered along its banks and at Reno are extensive oil works. The total population of this section is 17,980, divided as follows: urban, 15,500; rural, 2,480. Oil City, population 15,000, is the only town of any considerable size on this section.

The Allegheny River has been stocked by the Fish Commission with bass, yellow perch, pickerel, and pike perch.

With the discovery of oil the river from Oil City to Pittsburgh at once became a scene of intense activity. Keel boats and rafts and at times steamboats were used to carry the oil in barrels, and this continued for a number of years until the extension of railroad facilities provided a safer outlet. Some of the earlier steam-

boats plied the river as far up as Oil City, but the course was always somewhat dangerous and at times of low water quite impracticable. Numerous projects have been considered at various times for rendering the river navigable as far up as Oil City, and several surveys have been made by the United States government with this end in view, and it is probable that the improvements now being carried on further down may ultimately be extended to this point.

Industrially this division is of great importance, identified as it is with the great oil industry centring largely in and around Oil City. Petroleum, its production and refinement, and the manufacture of appliances connected therewith predominate. There are four large oil refineries at Oil City and the Conifer Oil Refineries at Reno about four miles down stream are very extensive.

Three lines of railroad parallel the river, branches of the Erie and the Lake Shore and Michigan Southern on the west side, and the Allegheny Division of the Pennsylvania on the east. These roads aggregate about twenty-five miles in all. There is also trolley service paralleling the railroads and extending from Oil City to Franklin.

The public water supplies in this division are those of Oil City and West End. At Oil City the supply is derived from driven wells along the river above the city to which the water percolates through a gravel stratum, probably coming from the river. An emergency crib intake is also maintained, the water works system being owned by the city. West End is supplied by the West End Water Company with water from three springs and three drilled wells. Industrial supplies are obtained from the river and from Oil Creek by a number of the larger plants at Oil City and by the Kramer Wagon Company at West End. Direct sewage pollution of the stream in this division is estimated to consist of the domestic wastes from 10,375 persons, 10,000 in Oil City, 125 in West End and 250 rural. The four oil refineries of Oil City and the large plant at Reno contribute a considerable amount of industrial pollution.

Oil City is an incorporated municipality of about 15,000 inhabitants situated at the junction of Oil Creek with the Allegheny River, the municipal territory being divided by these streams into three distinct districts. On either side of these streams are very steep and high hills with a narrow flat extending up Oil Creek valley and occupied by the business section. With the exception of these flats which are fifteen feet above the ordinary stage of the water, Oil City is a hillside community with residences extending up the bluffs on all sides. Its industries include four oil refineries, the Crystal, Continental, Independent and the Penn, as well as barrel works, boiler shops, plants for the manufacture of machinery, pumps, engines, oil well supplies, wagons and brooms, a foundry, wood-working shops, railroad shops, and three flour mills.

The city owns and operates a water works system, the source of supply being driven wells located along the banks of the river above the city. These wells extend about twenty-five feet below the river bed and probably draw water from the river indirectly through a stratum of gravel. The water shows up favorably on analysis and appears clear and good so far as the senses can detect. From these wells the water flows by gravity to the pump station. There is also a twenty-four inch suction pipe from the intake crib in the river to the pumping station whereby an emergency supply of raw river water may be and occasionally is obtained. Many of the industries, including railroads, derive industrial supplies from the river or creek and employees frequently use this water for drinking purposes. This condition, doubtless, has a material effect upon the prevalence of typhoid. The figures given below indicate the number of cases for twelve years prior to 1906, when State registration began.

	Cases.		Cases.
1894,	49	1900,	98
1895,	199	1901,	63
1896,	51	1902,	?
1897,	37	1903,	16
1898,	?	1904,	50
1899,	73	1905,	16

The sewers of Oil City are mainly combined storm and sanitary, serving about two-thirds of the population and discharging by way of numerous outlets into the river and into the creek. In 1906 the city authorities, at the suggestion of the Commissioner of Health, modified the design of sewers in the Eight Ward then under consideration as a combined system and, under a permit issued by the Commissioner of Health on June 20th, 1906, completed the system by the construction of both sanitary sewers and storm drains. This permit allowed the discharge of sewage into Oil Creek until July 1st, 1908, on or before which date plans for a comprehensive system, including treatment of all the sewage of the city were to be submitted. This was not done, but application was made for an extension of time. Siverly and West End boroughs have been urged to co-operate with Oil City in the matter of sewage disposal. The manufacturing plants, especially oil refineries, contribute more or less wastes of a deleterious character.

West End borough, with a population of about 500, is situated on the east bank of the river just below and adjoining Oil City, of which it is properly a suburb. Its industries are few and small, the principal plants being that of the Kramer Wagon Company, employing about fifty persons, and the Riverside Gas Engine Works, with about thirty employees. Water for domestic purposes is furnished by the West End Water Company. It is derived from three springs and three drilled wells. The entire population uses the water, the average consumption being about 120 gallons *per capita*. The Kramer Wagon Works has a private industrial supply taken from

the river. There are no municipal sewers and only three private sewers serving about sixty persons. These private sewers are said to discharge into storm sewers belonging to the borough, but such connections were made without the approval or consent of the borough authorities. Designs for a general sewerage system have been submitted to the Department and application made for their approval. These plans will be approved subject to certain conditions allowing their use for sanitary sewage only and a reasonable time will be given the borough in which to prepare plans for sewage disposal, preferably in conjunction and co-operation with Oil City. It appears that there are no industrial wastes of importance.

(b) *Oil Creek Drainage Area.* The East Branch of Oil Creek heads in the extreme southeastern part of Erie County and the northwestern part of Crawford County and flows in a southwesterly direction to its confluence with the West Branch at Centerville. The West Branch heads in the northeastern part of Crawford County in Canadohta Lake and flows southeasterly to its junction with the East Branch. From Centerville, Oil Creek takes a winding course, flowing southwest for a few miles when it bends to the east and flows southeast to Titusville. The direction of its course from Titusville through Venango County to its junction with the Allegheny River at Oil City is almost due south.

Both the East and West Branches of Oil Creek receive many tributaries throughout their course and flow, generally speaking, through barren waste lands, most of their length. In the vicinity of Centerville, where the valley is wide and rolling, there are numerous farms, probably the best in this basin. Between Centerville and Titusville the valley is about one-half mile wide, with numerous ravines and rolling wooded hillsides on both banks. There are a few farms in this section, most of them on the uplands some distance from the creek. At Titusville the valley widens to about one mile, the soil is well cultivated and numerous farms are found in this section. Below Titusville the valley steadily narrows, being about one-quarter of a mile wide at its mouth, while the creek itself is about 250 feet wide. In this section the bottom-lands are mostly waste, the banks are steep, in some places rising to a height of 200 feet above the stream and are covered with a poor second-growth timber.

Near the mouth of Oil Creek the petroleum industry of this country had its origin in 1855. At that time the oil was obtained by skimming the floating deposits on the water, but in 1859 the first well for the purpose of obtaining oil in large quantities was drilled near Titusville. Large numbers of wells were then put down and the industry developed rapidly all along the creek until 1882. The aspect of the valley from Titusville to the river is that of a thick forest of oil derricks. From 1882 to the present there has been a decrease in production, at first rapid and then more gradual.

Oil Creek drains an area of 285 square miles, including all the eastern portion of Crawford County, northern part of Venango County and the southwestern corner of Warren County. The soil of this district, especially the northern part, while often yielding abundant crops, is mainly adapted to grazing and can be most successfully used for such purposes. As a rule the soil is generally inclined to be cold and wet, so that the land has to be thoroughly underdrained before first-class crops can be raised. The valley of the creek itself is wide and flat in most parts; the hills rise abruptly often with cliffs from its flood plains, showing that its ancient bed lies far beneath its present surface.

The northern feeders of Oil Creek descend southward from the highlands with slopes of from fifty to a hundred feet to the mile. This fall steadily decreases, however, and the average slope for the entire stream is about ten feet to the mile. A gauging of this creek taken at Rouseville on September 27th, 1908, showed the minimum discharge to be 39.27 second feet.

Rainfall records have been taken at Oil City, covering a period of twenty-six years, and of these the records for twenty-three years are complete. They show the following results in inches per annum: maximum, 50.62; minimum, 22.80; mean, for total period, 42.04.

The total population of the basin is 21,900, divided into the following proportions: urban, 12,800; rural, 9,100. The total rural population is approximately thirty-two to the square mile.

Titusville, with a population of 10,000, is the only town of any size in the entire basin.

There are two water-power developments at Spartansburg, one of them of twenty horsepower, one small plant at Titusville and one at Centerville.

With respect to industrial occupations, agriculture is the dominant one in the upper portion of the watershed, but from Titusville down to its mouth the production of oil is pre-eminent. Aside from the woolen mills at Spartansburg, there are few industrial plants of importance except at Titusville and Rouseville. The industries of Titusville are varied and include three oil refineries, a number of furniture factories and wood-working plants, several steel and iron works, the Queen City Tannery of the Elk Tanning Company, and paraffin and soap works, and at Rouseville there are two refineries.

The Pennsylvania Railroad has a branch extending from Oil City the entire length of Oil Creek from the mouth to the head waters of the east branch of the creek with a branch line extending up the west branch, and a branch of the New York Central extends from Titusville in a northeasterly direction up Caldwell Creek, eventually reaching Warren and Buffalo. The total trackage on the watershed is about sixty miles.

Oil Creek is not used as a source of public water supply, except that it is available for emergency use at Titusville. The only public supplies on the watershed are the municipal plant at Titusville, an artesian well supply, and the Stone Hill Water Company at Rouseville, a small company deriving its supply from springs. The public generally throughout the watershed derive their domestic supply from private wells and springs. The Queen City Tannery at Titusville has a private industrial supply for emergency use derived from Oil Creek and at Rouseville the Germania Oil Company has an industrial supply taken from Cherry Run.

The vast number of oil wells between Titusville and the mouth of the creek produces a marked effect on the character of the water. Oil is constantly present on the surface of the water, sometimes to the extent of creating a decided nuisance, and considerable salt water also comes from these wells, salt water being usually associated with and underlying the oil as it is found in the ground. At Rouseville, where Oil Creek water is used for boiler and condensing purposes at the Crystal Oil Works, the amount of salt in solution is very appreciable. The water of Cherry Run used at the Germania Refinery at Rouseville contains salt, magnesia, and sulphate.

A field analysis of Oil Creek water at Titusville in 1906 showed the following results:

Field Assay of Oil Creek Water at Titusville, Pa., 1906.

	Parts per Million.
Turbidity,	50.0
Color,	180.0
Iron,	1.5
Calcium,	46.0
Total hardness,	39.0
Alkalinity,	36.0
Sulphates,	5.0
Chlorides,	5.6

Titusville is the only municipality having a public sewer system. It is estimated that the sewage of 8,105 persons, urban and rural, reaches the creek above Oil City. Aside from the ever present waste oil from the wells, the principal sources of pollution are the oil refineries.

Spartansburg, Crawford County, population 490, is situated in the northeastern corner of the county, near the head waters of the east branch of Oil Creek. The borough is at the lower end of a small body of water known as Clear Lake, which is about one mile in length and forms the head waters of the east branch. The water supply is

derived from private drilled and dug wells, there being no public system. There are no public sewers and but few private sewers from individual houses, privies being in general use. Kitchen wastes generally are discharged to the ground. The only industries of importance are the Tauber Woolen Mill, with about twenty employees, and a flour mill. There are two water-power installations here, one of them developing twenty horsepower.

Riceville, Crawford County, population 210, is situated on the west branch of Oil Creek, about three miles below its source in Canadohta Lake. The only industry of importance is the Marsh and Allen Handle and Saw Mill, employing about twenty persons. Water for domestic purposes is derived from private drilled and dug wells, there being no public system. There are no public sewers and but three private sewers, these being small drains for kitchen waste discharging into Oil Creek. Privies are in general use and kitchen waste is usually discharged to the ground, and there is but one cesspool.

Centerville, Crawford County, with a population of 300, is a borough situated in the eastern part of Crawford county at the junction of the east and west branches of Oil Creek. There is a small water power development here, but apparently no enterprises of industrial importance. Private wells and springs serve the inhabitants, there being no public water system. There are no sewers, public or private, privies being in general use, and kitchen wastes are discharged to the ground except in three instances, one to the highway and two to Oil Creek. A barn used as a slaughter house discharges blood and refuse through a hog-pen into a branch.

Hydetown, Crawford County, population about 400, is situated near the southeastern corner of the county on Oil Creek about three miles above Titusville. A small sanatorium is the only enterprise in the borough. A private water system, that of the Ridgway Estate, supplies a few houses with water from three drilled wells, from which water is pumped to a reservoir at an elevation of about 230 feet above the creek. Otherwise the inhabitants depend upon private driven and dug wells. There are three private sewers, one of them serving four properties and discharging into Oil Creek. Kitchen waste is generally discharged to the ground, though there are a few cesspools. Privies are generally used, some of them causing a nuisance in a small swamp in the borough.

Titusville, a city of the third class, population about 10,000, is situated in the extreme southeastern corner of Crawford County, adjoining the Venango County line, on Oil Creek. Its industries are quite extensive, including three oil refineries, steel works, four iron working establishments, paraffin works, soap works, Queen City Tannery of the Elk Tanning Company, and, until recently, the

Grasselli Chemical Company's acid works, which plant has recently been abandoned. There is also a water-power installation on Oil Creek at this point. The city owns its water works and supplies practically the entire population, there being few private wells or springs in use. The public water supply is derived from ten artesian wells on the banks of Oil Creek west of the city, and is said to be clear and abundant. An intake at the pumping station supplies crude creek water to the boilers and this supply is available for emergency used in the public system. The Queen City Tannery derives an emergency supply from Oil Creek. The city has a combined sewerage system with three outlets into Oil Creek, two into a mill-race and four into Church Run, the most important of them discharging into the last-named stream. There are also numerous small sewers emptying into the creek. The public system proving inadequate, the city proposes to install a separate system of sewers. Permits were issued by the Commissioner of Health on July 18th, 1906, and February 20th, 1907, approving the construction of certain sewers and requiring that a comprehensive plan for sewerage for the entire city be prepared, having for its object the ultimate disposal of all of the sewage of the city. It is estimated that 7,000 persons in Titusville contribute sewage to Oil Creek. Many of the industrial plants discharge manufactural wastes into Oil Creek, but these are not of an especially deleterious character, with the exception of the tannery wastes noted below. Formerly the acid works of the Grasselli Chemical Company discharged wastes which materially affected the quality of the stream.

Grand Valley, Warren County, is a borough situated in the southwestern part of the county near the head waters of Caldwell Creek, a tributary entering Oil Creek at the lower end of Titusville city. It has a population of 290. Its industries are unimportant. A privately owned water system supplies water from two springs on the hillside to some 150 consumers, the remaining population using drilled wells and a few springs. There is no public sewer system, but about ten properties, including a creamery, discharge sewage through private sewers into Caldwell Creek. Kitchen wastes are discharged to the ground except in a few instances where they go to the highways. In the northern part of the borough there is a slaughter house from which the refuse passes into the creek and thence through a hog-pen. The ice supply of the borough is derived from a pond formed by a dam across the creek at a point about 200 feet below the slaughter house.

Rouseville, Venango County, population 700, is a borough situated on Oil Creek, three miles above its mouth at Oil City. The borough is in the heart of the first oil field to be developed in the State and is essentially an oil town. Its principal industrial plants

are two refineries, the Germania Refining Company, with fifty employees, and the Crystal Oil Works, with eighteen employees. Water is supplied to the public generally by the Stone Hill Water Company, and is derived from springs. There is also a private spring supply serving a hotel and five families. In addition to this there are in use twenty wells and sixteen springs. The Germania Refining Company derives an industrial supply from Cherry Run and discharges into the creek wastes containing a small quantity of sulphuric acid, so it is reported. It is said that the wastes from the Crystal Oil Works are similar in character. There is no public sewer system and only a few individual private sewers. Privies are generally used, and kitchen wastes are discharged to the highways, stream or the ground. About one-half of the population probably pollutes the stream with sewage.

(c) *Typhoid Fever.* Not all of the cases of typhoid fever occurring at Oil City have been reported to the Department at Harrisburg. This is owing to the neglect of physicians to report their cases to the local board of health officers, or to the neglect of the local authorities to transmit the reports to the State Department of Health. In the following tabular form is given the number of cases reported by the local health authorities for the years 1906 to 1912, inclusive.

Typhoid Fever Cases Reported for the Section of the Allegheny Basin from Oil Creek to French Creek, 1906-1912, inclusive.

Town.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
Titusville,	13	22	17	15	32	8	Section 1
Oil City,	10	30	47	2	6	7	
Centerville,	0	0	0	0	2	0	
Hydetown,	0	0	0	0	0	2	
Grand Valley,	0	0	0	0	0		

Section 10.—French Creek to the Clarion River.

(a) *Along Allegheny River.* From Franklin the Allegheny River continues in a circuitous course through the south central and eastern parts of Venango County, a distance of forty miles to Foxburg, where the Clarion River enters. During this distance the hills follow the river quite closely, regular bottom lands being found only at the mouths of the large tributaries. The valley for the greater part of its distance is narrow, with high, rocky, wooded hills alternating on either side. Between the hills are numerous ravines. Small timber operations are carried on along the river in Venango County.

In the vicinity of Brandon, the bed of the stream is covered with boulders lying irregularly over each other. The pools in the river gradually deepen to fourteen feet or over and average a mile in length. From Franklin to Pittsburgh, the slope of the river averages 2.1 ft. to the mile. The total population of this section of the river is 33,150, divided as follows: urban 16,390, rural 16,760. Franklin city, the largest municipality in this territory, has a population of 10,000.

The tributaries have been stocked with trout by the State Fish Commission, and the Allegheny River with bass, yellow perch, pickerel, and pike perch.

Water power installations on this division are found on Little Scrub Grass Creek, twenty horsepower, on Rickey Run, on Sandy Creek, at Polk and Sandy Lake, and on Pine Run.

Relative to navigation, surveys were made and a very considerable amount of work was performed on the canalization of French Creek in order to obtain a navigable water way from Pittsburgh to Lake Erie; but the uncompleted canal was abandoned many years ago. The industries of this division are varied, oil and gas production predominating. Agriculture is of secondary importance. Sandy Creek marks the northern limit of coal production along the river proper. At Stoneboro on Sandy Creek and at various points along the river are found small mines of little importance. The railroads include the Pennsylvania, following east bank of the river, the Lake Shore & Michigan Southern, extending west from Franklin, and the Franklin and Clearfield, a new road from Franklin eastward through Clarion.

Ground and surface water supplies both private and public are in general use in the municipalities in this division. At Franklin an emergency supply is drawn from French Creek, which the Department has required to be filtered when used. At Emlenton, the use of six new wells has been approved, but should the supply prove inadequate and render necessary the return to the use of the river water, it is required that filters shall be installed. Foxburg is supplied from wells on a bluff overlooking the town; but an intake in the river formerly the source of supply, is maintained for fire protection only. A number of industrial plants, notably at Franklin, have private supplies for manufacturing purposes. Franklin, Emlenton and Foxburg have sewer systems to a greater or less extent, at Franklin serving 7,300 persons, about three-fourths of the population, and at Foxburg 600, the entire population. Industrial wastes are contributed by the refineries at Franklin and Emlenton and from the woolen mill at the latter place; but probably the chief source of industrial pollution in this division lies in the presence of a vast number of oil wells, waste oil from which reaches the streams in considerable quantities, especially during wet weather.

Franklin is a city with a population of 10,000, the county seat of Venango County. It is a manufacturing and residential community located on the west bank of the Allegheny River and on both banks of French Creek. The site of the town is principally on flats bordering the streams and hemmed in by high hills on all sides. It is reached by four railroads, the Erie, the Lake Shore and Michigan Southern, the Pennsylvania, and the Franklin and Clearfield. Its industries include a foundry of the American Steel Works, Pneumatic Tool Works, Rolling Mill, Manifold Works, Brass foundry, Machine Shops, Flour Mills, and plants for the manufacture of railway supplies and oil well outfits. The principal industries are located near the southern extremity of the city, including the plants of the General Manifold and Printing Company, 150 employees, the Colburn Machine Tool Company, 180 employees and the Franklin Railway Supply Company with 200 employees. Below French Creek there are a number of plants including the Galena Signal Oil Works, the Franklin Rolling Mill and Foundry Company, American Steel Foundry Company, Chicago Pneumatic Tool Company, and several Oil Well Supply Companies. The Venango Water Company formerly supplied the city with water and derived its principal supply from the ground in the vicinity of the pumping station by way of a large dug well and driven wells situated on French Creek. Copious springs and surface waters from the hillsides furnish a smaller portion of the water and when these supplies are insufficient, French Creek water is used. Permits have been issued from time to time by the Commissioner of Health for the use of additional springs and streams and on December 11, 1907, plans were approved and a permit granted for the installation of a filter plant and the use of French Creek water only after filtration. On July 15th, 1908, the city purchased the property of the Venango Water Company. There are some twelve and a third miles of combined sewers serving the city, principally ten-inch pipe and serving about three-fourths of the population, in many cases inadequately. The system has twelve outlets into French Creek or the river in addition to which the greater portion of the industrial plants have individual sewer outlets. In January, 1908, a permit was issued by the Commissioner of Health approving certain sewer extensions and permitting the temporary discharge of sewage into the waters of the State.

In the sewerage decree to Franklin of 1908, the Commissioner of Health had the following to say about the State's policy:

"Thirty miles below the mouth of French Creek the borough of Emlenton takes its water supply from the Allegheny River and so do other municipalities all the way down to Pittsburgh. The regulation of sewage discharge into this stream and its tributaries has been effected by the Commissioner of Health both above and below the city of Franklin in all those instances where, under the law, the Commissioner has jurisdiction. In no instance has a limit of over three years been granted beyond which sewage may continue to be discharged into the waters of the State. Oil City and Meadville have come under this regulation. At the present time

the city of Meadville is engaged in preparing plans for the purification of its sewage. In keeping with this policy, it is essential that the authorities in the city of Franklin should anticipate the treatment of the city sewage and do such work in the way of sewer extensions from now on as shall fit into and be a part of the comprehensive and complete, efficient and economical plan for the collection of all of the house drainage everywhere in the city and its deliverance to and purification in a disposal plant. Such a plan precludes the admission of storm water or much roof water into the sewer. If any storm water is to be admitted, then it should be limited to such a maximum quantity as it may be found practicable to receive and handle at the sewage disposal works.

"In solving this problem the best investment which the city can make is in the employment of proper engineering skill. As previously stated, a thorough knowledge of the existing sewers is requisite. Then judgment must be exercised as to how best to separate sewage from storm water in the existing sewers, and what sewers should be incorporated into the sanitary system and what sewers should be used exclusively for storm water. Then would follow the location or locations for the sewage disposal works and the devising of plans for the most efficient deliverance of the sewage there.

"When these things are done and the plan is approved and becomes official, it will be possible for the city to make sewer improvements without wasting money but not otherwise."

Sheakleyville borough, Mercer County, is a small rural community situated on a divide between the Shenango and Allegheny river watersheds and draining to the latter by way of Sandy Creek. It has a population of about 170. It has no industries except a small creamery, no sewers and no water system. Private drilled wells from sixty-five to seventy-five feet deep supply water to the community.

Stoneboro borough, Mercer County, with a population of 1,060 is located on the south side of Sandy Lake, a small body of water one mile long and one quarter mile wide, discharging by way of a short outlet into Sandy Creek. Ice harvesting forms one of the principal industries. A bituminous coal mine near by, which has since been abandoned, produced 27,000 tons in 1907. A few wells and springs are in use but a municipal water plant deriving its supply from springs discharging into a reservoir of 224,000 gallons capacity serves the greater portion of the population. Practically all of the few typhoid cases are said to have been brought in by railroad men. The borough is without sewers, kitchen waste being generally discharged on the ground, and streams and swamps used as a dumping ground for refuse of all kinds, producing an unsanitary state of affairs.

Sandy Lake, Mercer County, is a borough of 700 inhabitants situated at the lower end of Sandy Lake along its outlet. It is a rural community, its industries including a blacksmith shop, a wagon shop, and a few small coal mines in the vicinity. There is a mill race and a small water power development here, but to what extent it is used is not known. There are in use a number of driven wells, about thirty feet deep, from which an apparently good supply is derived, the water coming from a stratum of gravel overlain with clay, but the public generally to the number of about 500 are supplied by the Sandy Lake Water Company. This is a chartered company deriving its supply from springs and small streams. The borough has three storm drains but no public sanitary sewers. There are, however, a few private sewers from four to six inches in diame-

ter, discharging kitchen waste and sometimes sewage into the highways and into the mill race and Sandy Lake outlet. Loosely constructed privies and cesspools are largely used. The sanitary conditions of the town are unfavorable and typhoid fever is of quite common occurrence. The unsanitary conditions are in part due to the overflowing of Sandy Creek and to the gradual filling up of its bed and of the outlet of Sandy Lake, with sediment and debris. As a result the lower portion of the borough which was formerly dry ground and used for building and business purposes, has now become wet and swampy and a serious menace to the business prospects as well as the health of the borough.

The borough of Polk, Venango County, population 1,840, is situated on Sandy Creek at its junction with Little Sandy in the northwestern part of this county and about eight miles west of Franklin. About two-thirds of its area and three-fourths of its population are included in the State Institution for Feeble Minded of Western Pennsylvania. Industrially the interests of the borough centre chiefly about the institution. A small water power development on Sandy Creek exists at this point. Aside from the institution the inhabitants derive their water supply from private dug and drilled wells. There are no sewers and to the general use of privies and cesspools, the prevalence of typhoid has been attributed with apparent good reason. In 1903, there were 6 cases, in 1904, 6 cases; 1905, 8 cases; 1906, 15 cases; 1907, 4 cases, and in 1908, 3 cases. The discharge of sewage from nearly 1,500 persons at the institution into Sandy Creek within the borough limits, created a nuisance and as a result, the State Department of Health has designed and supervised the construction of a modern sewage disposal plant to purify the sewage from the institution. The water supply of the institution has been derived by gravity from four springs and in times of drouth from an emergency intake on North Sandy Creek. A sparse population on the watershed has made it desirable to abandon the latter sources and steps have been taken to acquire additional springs.

Clintonville borough, Venango County, population 320, is an inland town near the headwaters of Scrub Grass Creek in the southern part of Venango County. There are no manufacturing plants, the production of oil being the dominant industry. The town was considerably larger thirty years ago during the oil excitement in this part of the State, but in 1900, the number had reduced to 262. The recent discovery and development of a rich oil field in the country round about the borough has given the place a fresh impetus and some further increase in population may be expected, though it is an inland town accessible only by way of the public highways. Wells dug into the underlying limestone and drilled wells passing through into the deeper gravel formation form the sources of water supply

and are all private. A public water system using artesian well water is contemplated. There are no sewers in the borough. Kitchen drainage is thrown on the surface of the ground and into the highways. It may be expected that the water taken from the dug wells will sooner or later become polluted. The only source of pollution of the creek within the borough appears to be that coming from a slaughter house. A permit was granted October 9th, 1908, to the borough for the construction of a sewer system requiring the separation of storm water and sewage and the preparation of plans for a sewage purification plant before the sewers shall be built and used.

Eau Claire, Butler County, is a borough of 400 inhabitants, situated about six miles southwest of the Allegheny River at Emlenton. It is on a divide between the Allegheny and Beaver river watersheds and practically all its drainage goes to the latter stream. It is a rural community without water or sewerage systems. Kitchen waste is generally discharged to the ground but there is no record of any nuisance complaint.

The borough of Emlenton, Venango County, is located on the north bank of the Allegheny River. It has a population estimated at 1,300, largely interested in the production of oil, which abounds in the surrounding region. The Emlenton Oil Refinery and a woolen mill together with several small machine shops furnish the principal employment. Water is supplied to the community by the Emlenton Water Company, a chartered company whose source of supply is an intake with a free opening in the centre of the river, from which an eight-inch suction pipe leads to a pumping station, whence water is delivered to a reservoir of 367,000 gallons capacity. A permit was granted by the Commissioner of Health to the Emlenton Water Company on April 21st, 1908, approving the use of water from a new source, namely six drilled wells and requiring the abandonment of the use of river water provided, however, that if the well supply should prove inadequate, then the water company must install filters for the purification of river water. Emlenton has a public sewer system designed for sanitary purposes only, but receiving roof drainage as well. It comprises 3.8 miles of sewers and discharges through a twenty-inch cast iron pipe into the river near the lower boundary line of the borough. This system serves over one-half of the dwellings. Separate storm drains are provided, of which ten independent lines approximate a total length of 1.5 miles. There are also a number of private sewers discharging into the river. A permit was issued by the Commissioner of Health on April 27th, 1908, for the construction of certain sewers and requires comprehensive plans for sanitary sewerage for the entire borough and for the treatment of its sewage. Scourings and spent dye stuff from the woolen mill and trade wastes from the oil refinery both of which are above the borough, to some extent pollute the stream.

In the said decree of 1908, the Commissioner of Health had the following to say about stream pollution in the neighborhood:

"Four miles below Emlenton is the village of Foxburg and three miles below this village is Parker City. Both of these places have for years taken their supply of drinking water from the Allegheny. Recently the Foxburg Water Supply Company has sought a new supply from wells and springs on the hillside back of the town.

"But below these towns along the river all the way to Pittsburgh there are numerous municipalities which do now and must continue to rely on the river for a public supply of water. It is the pollution of the river by sewage at Franklin and Oil City and other places in the valley above Emlenton that has compelled the Emlenton Water Company in safeguarding the public health to seek a new supply, but the greater proportion of the inhabitants of river towns cannot thus avoid the menace which sewage poisons in the river establish. It has become a State policy to preserve the purity of the State for the protection of the public health and in the administration of this great and beneficent law a policy has been inaugurated which will ultimately require the abandonment of the discharge of all sewage into streams used subsequently for drinking waters.

"While the small borough of Emlenton may not be compelled to take its sewage out of the river sooner than some other places, yet the local authorities should be informed of the State's policy and the necessity thereunder of plans being laid out in the borough for a sewer plan involving the ultimate treatment of the town's sewage."

Foxburg, Clarion County, is a small village just above the mouth of the Clarion River, in Richland Township, population about 600 and no industries. The surrounding region is productive of oil and the inhabitants of the village depend chiefly upon this industry. It has a sewer system provided by the Fox estate, which owns most of the village, and also controls the Foxburg Water Works Company. The company formerly derived its supply from an intake crib in the bed of the river. This supply is now used only for fire protection and a new source has been obtained, consisting of four six-inch wells drilled on a crest of the mountain immediately back of the village. A permit was granted on May 4, 1908, by the Commissioner of Health for the use of this supply.

(b) *French Creek Drainage Area.* French Creek is the second largest tributary of the Allegheny River. Its head waters are partly in western Chautauqua County, New York, partly in the extreme eastern part of Erie County and partly on the high divide in north Erie County overlooking Lake Erie, at an average of ten miles from the shore. The extreme eastern head waters of the North Branch are in the southwestern part of Chautauqua County, New York. This stream flows in a general southwesterly direction for about twenty miles where the South Branch joins it coming from the east. From its source the South Branch runs due north through a deep cut at the head of Oil Creek and reaches the valley bed about one mile west of Corry. From here the stream turns to the south and then to the west and flows, with many sharp bends through the southeastern portion of Erie County, in a westerly direction to its confluence with the North Branch near LeBoeuf. The ravine through which the head waters of this Branch flow is a very remarkable through cut valley, the walls of which are 1,850 feet above sea level. From the junction of these branches, French Creek continues in a general

southwesterly direction with many bends and curves through Crawford County to Meadville, twenty-eight miles above its junction with the Allegheny River; thence in a wide gentle curve it flows south east through the extreme northwestern corner of Mercer County into Venango County and enters the Allegheny River at Franklin, 126.4 miles above Pittsburgh.

The most important tributaries are Conneantee Creek, Cussewago Creek, Conneantee Lake Creek, and Sugar Creek. West of French Creek the whole country is so eroded that few of the uplands exceed 875 feet above the lake level. These tributaries drain southward from the divide through flat valleys, one and often two miles wide, bordered by low and gently rounded hill slopes, and separated by low flat table lands. Sugar Creek, the largest tributary entering French Creek on the east side, heads in two branches in the southeastern part of Crawford County in drift filled valleys and flows southward, forming a confluence with French Creek about five miles above Franklin.

The fall of French Creek is very irregular, due in a measure to its exceedingly winding course. From the watershed of these headwaters to Greenfield the rate of fall is about thirty-three feet to the mile. From Greenfield to Wattsburg the rate of fall is about nine feet in a mile; from Wattsburg to the forks, the rate of fall is about fourteen feet to the mile and from the forks to Franklin a distance of sixty miles, the rate of fall is four feet to the mile. The northern affluents of the South Branch descend from the highlands at a maximum rate of sixty feet to the mile while the rate for four miles before it joins the North Branch is only three and a half feet to the mile. A gauging of this creek at Carlton on September 27th, 1908, showed the minimum discharge to be sixty-four second feet.

Rainfall records kept at Saegertown for fifteen years consecutively and at Franklin for twenty-nine complete years covering a total period of thirty-six years are given below in inches *per annum*.

	Maximum.	Minimum.	Mean.
Saegertown,	52.20	31.97	44.76
Franklin,	59.79	31.70	42.94

French Creek drains an area of 1,180 square miles including the southwestern part of Chautauqua County, New York, the central and eastern parts of Erie County, the central part of Crawford County, the extreme northwestern corner of Mercer County and the northwestern part of Venango County. The stream is a sluggish and winding one. The valley is generally broad and the bottom lands are under

cultivation to a considerable extent. Shoal waters and a rocky bed afford excellent opportunities for fords. In the vicinity of Meadville the valley of French Creek is wide and flat and part of the city is subject to overflow. Below Meadville during dry seasons, the stream is a succession of pools and shoals and sewage is afforded an opportunity for sedimentation and aeration. This accounts for lack of evidence of sewage pollution in some of the samples of water taken from the creek at Franklin.

The soils of this district while they often yield bountiful crops are best adapted for grazing. There are two principal classes of soils, one derived from decomposition of drift material and the other originated in the decay of vegetable matter in the vicinity of bogs and swamps. Soil from the drift is strong, clayey and gravelly, rich in fertilizing elements but is inclined to be cold and wet so that the land has to be thoroughly drained before first class crops can be raised. The swamp soils, of course, require draining, but they possess almost inexhaustible fertility. The total population of this basin is 72,820 divided as follows:

	New York.	Pennsylvania.
Urban,	800	28,260
Rural,	3,280	40,480

The rural population is approximately thirty-seven to the square mile.

The only municipalities in this basin with a population over 1,000 are Meadville, population 15,000, Union City, population 4,000 and Cambridge Springs, population 2,000.

French Creek and most of its tributaries have been stocked with game and food fish.

French Creek is largely used for water power, operating small mills generally. The following is a list of the water power installations, on French Creek and its tributaries.

Erie County.		
French Creek,	Wattsburg,	25 H.P.
French Creek,	Mill Village,	50 H.P.
French Creek,	Union City,	100 H.P.
West Branch French Creek,	Lowville,	
Black Run,	Waterford,	
Beaver Run,	Elgin,	40 H.P.
Crawford County.		
French Creek,	Venango (4 plants),	1 of 80 H.P.
French Creek,	Saegertown (3 plants),	1 of 160 H.P.
Little Conneauttee Creek,	Drakes Mills,	75 H.P.
Conneaut Creek,	Geneva,	

Conneaut Creek,	Conneaut Lake,	
Cussewago Creek,	Meadville,	100 H.P.
Muddy Creek,	Little Cooley,	50 H.P.
Muddy Creek,	Little Cooley,	57 H.P.
Woodcock Creek,	Meadville, vicinity,	16 H.P.
Woodcock Creek,	Blooming Valley,	31 H.P.
Woodcock Creek,	Saegertown vicinity,	

Venango County.

French Creek,	Franklin,	100 H.P.
East Branch Sugar Creek,	Cooperstown (2 plants)..	

During the period of activity on the part of the State in the construction of canals, a project was partly carried out to secure transportation by water from Franklin by way of French Creek and Conneaut Lake to Lake Erie at Erie. Canals, feeders, dams and locks were constructed securing eighteen miles of slack water and twenty-seven miles of canal navigation, at a cost of \$872,780. This was known as the French Creek Division and was operated from 1834 to 1845. The lower portion, which has never been much used was abandoned in 1845 and the same year the uncompleted French Creek feeder was sold to the Erie Canal Company. Some of the dams in French Creek still exist. The total revenue during this period was \$5,820 while the cost of operation and maintenance was \$143,000.

The French Creek watershed is essentially an agricultural region, though the lower portion produces petroleum and natural gas in considerable quantities. Coal is not found except in few isolated deposits, and nowhere of sufficient importance to warrant extensive operations. Meadville is the principal manufacturing town but the industries are not of great extent. Transportation facilities are afforded by about 124 miles of railroad, including the Western Division of the Pennsylvania, the main line of the Erie, the Franklin Branch of the same road, a branch of the Bessemer and Lake Erie and a small portion of the Lake Shore and Michigan Southern.

Domestic water supplies are derived generally from wells or springs and in a few instances from French Creek. Union City has a municipal water works system deriving its supply from small runs and springs in the vicinity augmented at times by French Creek water. At Waterford the Waterford Water Company supplies a few families with spring water. Cambridge Springs has a municipal water system using French Creek water, which is filtered before being furnished to the consumers. Meadville has a municipal supply derived from drilled wells, while French Creek water may be used in emergencies. Cochrannton has a municipal supply derived from two springs.

A number of municipalities have sewer systems of greater or less extent and it is estimated that an urban population of 20,000 persons contribute domestic sewage to the waters of French Creek above the city of Franklin. Industrial waste pollution has not been thoroughly investigated, but probably the most important wastes are those from the tannery of Boland & Ross at Cambridge Springs where 125 hides a day are treated, the quality of wastes being characteristic of tanneries and amounting to probably 50,000 gallons a day.

A sanitary analysis made of French Creek water at Meadville and a mineral analysis made of French Creek at Franklin are given in Table XXXVI:

TABLE XXXVI.

Sanitary Analysis of French Creek at Meadville, May, 1901.	Parts per Million.	Mineral Analysis of French Creek at Franklin in Nov., 1909.	Parts per Million.
Turbidity,	75.00	Total Solids,	139.2
Color,	0.42	Loss on Ignition,	8.4
Odor,	Vegetable	Alkalinity,	75.1
Residue on Evaporation:		Chlorine,	28.7
Total,	165.5	Sulphuric oxide,	24.3
Suspended,	96.	(Calcium Sulphate).	
Dissolved,	69.	Magnesium Carbonate,	3.6
Volatile,	33.		
Non-volatile,	132.		
Nitrogen as Album. Am.:			
Total, .....	.236		
Suspended, .....	.108		
Dissolved, .....	.178		
Free Ammonia, .....	.040		
Nitrites, .....	.063		
Nitrates, .....	.240		
Chlorine, .....	.400		
Iron,	2.300		
Total Hardness,	25.60		
Alkalinity,	30.00		

Sherman, Chautauqua County, New York, is an incorporated village with a population of 800, situated at the extreme head waters of French Creek near the boundary line of the three watersheds, French Creek, Conewango Creek and Lake Erie. It is estimated that approximately 440 persons contribute either directly or indirectly, sewage to the waters of French Creek.

Wattsburg, Erie County, Pennsylvania, population 350, is a borough situated in the eastern part of the county at the junction of the east and west branches of West Creek. It is a rural community with no railroad nearer than about six miles and has no industries of importance. There are a small planing mill, saw mill, and flour mill operated by water power. There is no public water supply, private driven and dug wells being used exclusively. The underlying formation is gravel and a good supply of water is found at depths not exceeding twenty feet. Dug wells are not generally over twelve feet in depth and the water is soft, the level of the wells fluctuating somewhat with the depth of water in French Creek. The borough has no sewer system and but one private sewer which serves a hotel

and discharges into the mill race. Surface privies are in general use. Probably thirty persons contribute direct or indirect pollution to the stream.

Elgin, Erie County, population 140, is a borough situated on the south branch of French Creek in the southeastern part of Erie County with no industries of note. Private artesian and dug wells supply water to the inhabitants, there being five flowing wells drilled to a depth of from 100 to 300 feet. There is no public sewer system and but one private sewer discharging sewage. A 40 horsepower development forms a pond on Beaver Run which stream receives the most of the drainage of the borough, entering French Creek within the borough limits. Kitchen wastes are discharged usually to the ground. About one-fourth of the people contribute sewage pollution to the creek and privies are in general use.

Union City, Erie County, is a borough with about 4,000 population situated near the southern boundary of the county on the south branch of French Creek. It is a manufacturing community having good transportation facilities afforded by the Erie and the Pennsylvania Railroads. Its industries comprise the Shreve Chair Company, 250 employees, Standard Chair Company 200 employees, Novelty Wood Works, 125 employees, Union City Laundry 70 employees, Union City Chair Works 300 employees, planing mills and flour mills. The municipal water system derives its supply from Bentley Run and Limekiln Run and springs, augmented at times by water pumped from Little French Creek at a point in the heart of the borough. The public generally use the town water and about one-fourth of the citizens are partly or wholly supplied with drinking water from drilled or driven wells and a few dug wells and springs. Several of the industrial plants have artesian wells for drinking water. One hundred horsepower is developed at a water power installation at this point. The borough is partly sewered, the drains having been built by the borough and by private individuals. It is reported that at present all of the sewers are recognized as belonging to the borough and all carry storm water, domestic sewage, and manufactural wastes. There are numerous cesspools, and a large number of privies with percolating vaults. In July of the year 1912 there were fifty-four estates from which drainage, in some cases from closets, was being discharged unto the gutter and along the highways. The major portion of the sewage pollution is contributed by nine sewers below the dam and numerous private sewers above. About a thousand persons are so served, the private sewers above the dam polluting the borough's own emergency water supply. On December 3rd, 1908, the Commissioner of Health issued a permit for the construction of certain sewer extension and required the immediate preparation of plans for a comprehensive system of sanitary sewerage and sewage purification works.

Among other things in the decree of 1908, the Commissioner of Health made the following statements:

"The use of Little French Creek as a source of unfiltered supply to the inhabitants of Union City borough is a menace. Public health demands that the sources of pollution shall be discontinued at once. It is equally true that the discharge of sewage into the stream at Union City borough menaces public health at Cambridge Springs. While natural agencies tend to destroy pathogenic organisms soon after these leave their normal environments, in the animal body, nevertheless, some of these specific poisons may live for many days in water and thus be transported to distant points. Fatal epidemics in most communities have been caused by such transmission of infection. The State Health authorities cannot accept the situation as protective of public health where it is planned to continue the discharge of sewage into a running stream within twenty-three miles of and above the point where water is drawn for public drinking purposes. And besides, all along the French Creek, above Cambridge Springs, at convenient points the farmers have a right which must be respected, to water their stock in the stream. Sewage polluted water menaces public health where cattle are permitted to wade in and drink contaminated water.

"On August first, nineteen hundred and six, the Commissioner of Health sent a letter to Union City Borough Council. The following is a copy of it:

"J. A. Hodgins, President; John Sinnacher, Frank Camp, E. B. Landswarth, Elmer Foster, Clark Rice, members of Borough Council, Union City, Erie County, Pa.

"Gentlemen: Your borough is on French Creek and its sewers discharge into it and a few miles below the borough of Cambridge Springs uses this water for a public supply.

"You also use French Creek water which is introduced into the pipe system of your borough when the gravity supply is insufficient. This use of the creek water is a menace to your citizens which menace may be materially reduced by a proper attention to the occupation of the watershed.

"To the end that selfish interests of municipalities shall not jeopardize the general public health, a law has been passed placing the oversight of sewerage systems and waterworks in the State Department of Health. The law requires the filing of plans and reports with respect to these public necessities, and you have been furnished by this Department with blank forms.

"Up to this time you have paid no attention to this matter so far as we know. You have not acknowledged the receipt of the blanks. My Department has use for the information called for and unless you acknowledge the receipt of this letter, expressing your purpose with respect to compliance with the law, I shall consider it necessary to proceed against you and enforce the penalty. I trust this will not be necessary, however, but that as law abiding citizens of the Commonwealth you will extend hearty co-operation since the benefits will accrue to the benefit of the citizens of your borough.

"I am, very truly yours,

"SAMUEL G. DIXON."

"The town is engaged in improving its water supply, which is a public necessity. The assessed valuation of property in the borough is seven hundred and eighty thousand, one hundred and forty-four dollars; the bonded debt is thirty-four thousand, four hundred and twelve dollars and twenty cents, and there is authorized a bond issue of seventeen thousand five hundred dollars for water works extensions and other improvements, making a total debt of practically fifty-two thousand dollars, which is within twenty-five hundred dollars of the constitutional limit of indebtedness of the borough at this time, provided these figures be accurate. So it is evident that the town cannot of its own resources, build a sewage disposal plant, but it can defray the cost of plans for intercepting all existing sewer outlets and for a comprehensive system of sanitary sewerage for the entire town and submit these plans for approval to the State Department of Health. After such plans have been modified, amended or approved and adopted, the borough will be in a position to economically and efficiently abate any nuisance or menace requiring improved sewerage facilities and do it in compliance with the adopted plan.

"Furthermore, it does not follow, because a borough lacks the necessary money to abate a nuisance, that a public menace shall necessarily be permitted to exist. There are numerous places in Union City where individuals should be dealt with in abating the nuisance. For instance, the individual discharge of sewage into the creek above the dam and water works intake is absolutely impermissible and must be stopped at the expense of the individual. The Department of Health will see to it that orders are issued to this effect."

Waterford, Erie County, is a borough with a population of about 800, situated on LeBoeuf Creek and LeBoeuf Lake, a body of water with an area of about half a square mile and about two miles above the confluence of the creek with French Creek. The country round about is wholly agricultural and the village is residential, its industries comprising a carriage shop, blacksmith shop, and grist mill. There is a small power development on Black Run. The domestic water supply is generally obtained from dug wells on individual properties, but the Waterford Water Company operates a gravity supply from springs in the northeastern part of the borough and supplies about forty families and ten fire hydrants. A permit was issued by the Commissioner of Health to the Water Company on April 30th, 1908. There are no public sewers and but one private sewer, this leading from the hotel to a swamp in the northwestern part of the borough. Domestic waste from dwellings is discharged into cesspools and privies and the underlying subsoil being of a clayey, retentive nature, there is apparently little danger of subsoil pollution of the numerous dug wells. It is estimated that forty-five persons contribute pollution to the creek.

Mill Village, Erie County, population about 320, is situated near the southern border of the county on Avery Run near French Creek. A creamery is its only industry. There is no public water system, the inhabitants deriving their water for domestic purposes from driven and drilled wells and a few private springs. There are no sewers except one from a hotel discharging sewage into Avery Run. Kitchen wastes are generally discharged on the ground and in a few instances direct to the run. Two cesspools are in use. Several privies are on the bank of Avery Run.

Townville, Crawford County, population 500, is a borough situated in the central part of the county on a small run near the headwaters of Muddy Creek. The latter stream flows in a northwesterly direction entering French Creek about four miles above Cambridge Springs. Its industries are unimportant, comprising a blacksmith shop and a small cheese factory. The borough has no public water system, about one-half of the population deriving their supply from springs and the others from drilled and dug wells. There is no public sewer system, but there are four individual sewers to the run discharging sewage, beside which there are some twelve pollutions, mainly small sewers discharging kitchen wastes. The wastes from the cheese factory are to a nine-inch sewer.

Cambridge Springs, Crawford County, is a borough with a normal population of about 1,800, increasing during the summer months to about 4,500, the average population being in the neighborhood of 2,000. The principal interest of the borough centres around the existence of a number of mineral springs noted for their curative

properties, and a number of large hotels which accommodate the transient population attracted by the springs during summer months. There is a tannery here, owned by Boland & Ross, which handles about 125 green hides a day using extract in the tanning process, lime for dehairing, and a small amount of acid for bleaching. This borough has a municipal water works system pumping water from French Creek. Formerly this water was delivered to a 125,000 gallon wooden standpipe, and thence by gravity to the consumers. Five wells were drilled and put in service, but later abandoned as the water was unpalatable. Most of the drinking water, however, was derived from many private driven wells scattered throughout the town, the public in general realizing the danger of drinking the French Creek water. In response to a demand by the State authorities, the borough has installed a mechanical filtration plant for the purification of the French Creek supply, and on August 15th, 1907, and October 2nd, 1907, the Commissioner of Health issued permits for the construction of the filtration works and the use of the filtered supply from French Creek. The borough has a public sewer system built without regard to any definite comprehensive plan and without consideration of its relation to the public water supply. There are three main sewer outlets, one of which is above the waterworks intake and is twenty-four inches in diameter, serving a permanent population of about 600 and a summer population of about 2,600. The other two outlets are eighteen inches in diameter. The public sewers serve approximately two-thirds of the permanent population, the remainder using privies. Decrees were issued by the Commissioner of Health on April 29th, 1907, July 1st, 1908, and October 9th, 1908, approving certain sewer extensions, including a project for changing the point of discharge of the sewer with outlet above the water works intake to a point below. Aside from the sewage pollution coming from the borough which may be considered as being contributed by at least 1,500 persons continuously, there is a tannery waste pollution amounting to 50,000 gallons a day, roughly estimated.

Edinboro, Erie County, population 900, is situated in the southwestern part of Erie County at the lower end of a small body of water known as Conneauttee Lake and on its outlet, Conneauttee Creek, which enters French Creek a short distance below Cambridge Springs. Aside from farming, the chief interest of the borough centres about the State Normal School, connected with which there are about 500 scholars and teachers. The domestic water supply for Edinboro is derived mostly from driven wells and partly from two dug wells. One private system supplies six properties and another some seventeen properties with ground water. Outside privies and about a dozen cesspools are used by a large portion of the inhabitants. There are also three private outlet sewers, two of which dis-

charge the sewage from the Normal School. In response to an application from the borough authorities to increase the sewerage facilities by the construction of certain sewers, the Commissioner of Health issued a decree on April 29th, 1907, withholding approval of sewer extensions until such time as the borough shall have submitted plans for a comprehensive sewerage system and disposal works.

Woodcock, Crawford County, population 110, is a small rural community without water works or sewers. Water is derived from private dug wells, privies are in general use, and kitchen waste is discharged to the ground. A small cheese factory and a slaughter house within the borough limits are the only industries noted. There appears to be no pollution, either domestic or industrial, of the waters of the State by this borough.

Venango, Crawford County, population 230, is a borough situated in the northern part of the county on the west side of French Creek and about three miles south of Cambridge Springs. A cheese factory, employing eight persons, and a grist mill are the only industries in the borough. Water is derived from private driven and drilled wells. There are four water power developments reported in or near Venango on French Creek, one of them developing 80 H. P. There are no sewers except one storm sewer eight inches in diameter. Privies are in general use.

Blooming Valley, Crawford County, population 150, is a borough situated on Heronhead creek, a small tributary of Woodcock Creek which latter stream enters French Creek at Saegertown. There is a water power development on Woodcock Creek of about 30 H. P. The borough has no public water system, the inhabitants using private drilled and driven wells and a few springs. There are no sewers. Kitchen wastes are discharged generally to the ground.

Saegertown, Crawford County, population 990, is a borough situated on French Creek a few miles above Meadville. Within the borough is the Crawford County Home with ninety-two inmates. The Saegertown Inn, a health resort, owns mineral springs and a bottling establishment is connected therewith. There is also a flour mill here. There are three water power installations in or near the borough, one of them developing 160 H. P., all on French Creek. There is no water system, the inhabitants being supplied from driven and drilled wells and a few dug wells and springs. There are a few storm sewers, but no sanitary sewers except a small number belonging to individuals. Of the private sewers, four are from the Inn property, three to French Creek, and one to a storm sewer. One other private sewer enters a public storm sewer, and one enters the mill race.

Meadville, Crawford County, population 15,530, a city of the third class and the county seat, is situated near the central part of the county on French Creek. It is a distinctly residential community

in an agricultural district with few industries of extensive importance. The Phoenix Iron Mills and the Meadville Malleable Iron Company have the largest plants, beside which there are boiler, vice, tool, and corset works, a distillery, brewery, saw mill, and grist mill. A water power installation on Cussewago Creek develops 100 horsepower. There are two institutions of learning of considerable importance, Allegheny College, with 400 to 500 students, and the Unitarian Theological Seminary. The city owns its own water works, electric light plant, sewerage system, and garbage crematory. The public water supply is drawn from about twenty driven wells and from French Creek for emergency uses, but since 1904 the French Creek water has been used only on one or two occasions. The city has a comprehensive system of sewers receiving sanitary sewage and only such storm water as falls on the roofs of buildings. The sewerage system aggregates eighteen miles of sanitary sewers with two outlets respectively thirty-six inches and twelve inches in diameter in addition to which there are about two miles of private sewers. Sewage is discharged by gravity during all but high stages of French Creek, at which time the sewage from the larger outfall is pumped by means of an electrically operated, centrifugal pump with a capacity of about 4,000,000 gallons daily. Cesspools and privies are commonly used, the sewage of only about 8,000 persons being discharged through the public system. On December 14, 1906. the Commissioner of Health issued a permit to the city of Meadville for the extension of certain sewers and requiring the preparation of plans for a comprehensive sanitary system and sewage disposal works. There are no manufacturing wastes of importance contributed by the industries of Meadville.

In a decree dated May 1911 issued to the city of Meadville relative to sewerage in response to an application for approval of plans for a comprehensive system of sewers and sewage disposal works the Commissioner of Health had the following to say:

"The plans, with the report and specifications, which are hereinbefore reviewed, were accepted by the city of Meadville in a joint session of councils on November eighteenth, one thousand nine hundred and eight. In October, one thousand nine hundred and ten, the reported total assessed property valuation of the city amounted to three million seven hundred and ninety-nine thousand and ninety-eight dollars. On this date the city had a bonded indebtedness of two hundred and seventy-six thousand dollars towards the payment of which there is a sinking fund of one hundred and one thousand, five hundred and thirteen dollars, leaving a net bonded debt of one hundred and seventy-four thousand, four hundred and eighty-seven dollars. The city can, therefore, borrow about ninety-one thousand dollars before the seven per cent. limit of municipal indebtedness permitted by law is exceeded. The sum of five thousand dollars is being set aside annually and placed on interest as a fund for the construction of a sewage disposal plant, the first installment of this fund having been made in one thousand nine hundred and nine. In all probability the city will be able to cancel the first issue of municipal water bonds, amounting to one hundred and eighty-eight thousand dollars in about six years, and its borrowing capacity will be increased by this amount. At the end of this six year period, moreover, the sewage disposal works fund will amount to thirty-five thousand dollars.

"At the present time the city is financially unable to assume the expense of making all of the sewerage improvements called for in the design submitted. There appears to be an urgent need for the installation of sewers in the Fifth Ward and this portion of the proposed work will probably be first taken care of. It appears, however, that under the estimate of cost prepared by the experts, the city can install the proposed Fifth Ward sewer system complete, build and equip the various pumping stations, lay the force mains and construct the preliminary settling tank of the disposal works for the sum of sixty-eight thousand five hundred dollars. This amount deducted from the ninety-one thousand dollars available, leaves a balance of twenty-two thousand five hundred dollars, to which should be added the ten thousand dollars already accumulated in the sewage disposal plant fund, making a total of thirty-two thousand five hundred dollars available for building the balance of the plant. As much of this sum as is necessary could be applied to the construction of a germicidal dosing plant and the sewage from the city, treated in the preliminary settling tank and suitably dosed, could then be discharged into French Creek until such time as its finances would permit the city to complete the balance of the sewage purification works. An increase of the city's indebtedness in an amount sufficient for the sewerage improvements outlined will have to be authorized by a vote of the electors.

"Or it might be feasible for the city to enter into an agreement with a contractor who, for a sum of money to be paid by the city annually for a period of years, would make the necessary extensions to the sewer system, build the pumping stations and sewage disposal plant and operate the latter until such time as a sufficient amount is paid to cover the cost of the construction and operation of the plant, when it would revert to the city. This method was employed at Reading, Pennsylvania, and that municipality, under its contract, will at the end of a stated period own its sewage disposal works. The necessity for the city of Meadville to purify its sewage has been fully set forth in the permit issued to the city by the Commissioner of Health on September 14th, 1906."

Conneaut Lake, formerly Evansburg, Crawford County, population 340, is a borough situated at the southern end of Conneaut Lake near its outlet. Aside from the harvesting and storing of ice, the industries are of little or no importance. A small water power development exists on Conneaut Lake Creek, the outlet of the Lake. There is no public water system, about three-fifths of the population depending on driven wells and the remainder on dug wells. A twelve inch public sewer, nominally a storm sewer, receives some sanitary sewage, but aside from this, there are no public sewers. Kitchen waste is generally discharged to the ground and in a few instances to highways or a small run.

Geneva, Crawford County, population 220, is a borough situated in the southern part of the county on Conneaut Lake Creek, which drains Conneaut Lake and empties into French Creek. The drainage from the town reaches the stream by way of Marsh Run. The only industry noted is a cider mill and preserving factory. Water is derived from private drilled wells and a few dug wells and springs. The borough has no public sewer system and only two or three private sewers from individual properties. Kitchen wastes are discharged for the most part to the ground and in a few instances to the run. The wastes from the preserving and cider mill produce disagreeable odors and a nuisance in the run near by.

Cochrannton, Crawford County, population 640, is a borough situated on French Creek near the southern boundary of the county. Its industries are small, comprising a machine shop, a saw mill, a handle factory, and a grist mill. The borough has a public water system deriving a gravity supply from two springs, the surplus overflowing to a tank reservoir with a capacity of 166,000 gallons. Cess-

pools of good construction are in general use and though there are no sewers, it is reported that there are no pollutions of the stream by sewage or industrial wastes.

New Lebanon, Mercer County, is a borough with a population of about 300 situated in the northeastern part of Mercer County at the head waters of Mill Creek, a tributary entering French Creek at Utica, Venango County. It is an agricultural community deriving its water supply from dug or driven wells or springs on individual properties. There are no sewers with the exception of four private drains discharging kitchen waste from individual properties to the highway.

Utica, Venango County, population 300, is a borough situated on French Creek about nine miles from its confluence with the Allegheny River at Franklin. It has no industries and no waterworks nor sewer system. Cesspools are scarce and kitchen waste is discharged to the ground or to the creek. There are three private sewers from individual properties discharging sewage into the creek.

Cooperstown, Venango County, population 350, is situated in the northwestern part of the county on Sugar Creek about six miles from its junction with French Creek. There are two water power installations of minor extent on Sugar Creek at this point. Individual wells and a few springs form the water supply. The only sewers are two twelve inch storm drains discharging into Sugar Creek, and one private sewer. Kitchen wastes are discharged to the ground.

(c) *Typhoid Fever.* The typhoid fever cases reported by the local authorities for this section of the Allegheny Basin to the State Department of Health for the years 1906 to 1912 inclusive are shown in the following table:

TABLE XXXVII.

Typhoid Fever Cases Reported for the Section of the Allegheny Basin from French Creek to the Clarion River, 1906—1912, inclusive.

Town.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
Meadville,	29	28	10	1	4	7	2
Cambridge Springs,	0	0	3	1	0	0	0
Conneaut Lake,	0	0	3	0	1	1	0
Cochrannton,	0	0	0	0	5	1	7
Geneva,	0	0	0	0	3	0	0
Blooming Valley,	0	0	0	0	0	1	0
Paagertown,	0	0	0	0	0	1	0
Venango,	0	0	0	0	0	0	1
Union City,	3	6	10	1	4	8	40
Edinboro,	1	0	0	1	0	1	0
Mill Village,	0	0	0	0	1	0	0
Stoneboro,	8	2	1	0	0	1	0
Franklin,	79	83	28	25	51	54	37
Polk,	25	4	3	6	6	5	0
Emlenton,	9	7	6	1	15	9	9

Section 11.—Clarion River to Red Bank Creek.

(a) *Along the Allegheny River.* For twenty-one miles below Foxburg and the Clarion River the Allegheny flows in a south by east direction, in a winding course along the western border of Clarion County to the point where it is joined by Red Bank Creek. Throughout the greater part of this section the valley is bordered by rocky, wooded banks with narrow strips of bottom land alternating on each side. Gentle hill slopes, followed closely by slopes more abrupt are characteristic. The pools in this part of the river are quite deep and the beds of some of them are composed of large fragments of rocks brought down and dropped by ice. Above Parker there are no coal mines but below they are numerous throughout the course of the river. Below East Brady are many rugged ravines, and high wooded bluffs line the east bank of the river to Red Bank Creek. The population of this part of the Allegheny River basin is 10,580 divided as follows: urban 4,240, rural 6,340. The principal towns in this section are East Brady and Parker, each with a population of about 1,300. During the height of the oil excitement, Parker was a city of several thousand inhabitants.

This stretch of the Allegheny River has been stocked with the same kind of fish as the stretches above described.

Relative to industrial occupations, the production of oil and coal form the dominant interests through this section of the river. Bituminous coal mines begin to appear in increasing numbers as one proceeds down the river and are found scattered along its banks from Parker to Pittsburgh. There are twenty-nine mines reported within the drainage area tributary to this section of the river and the principal manufacturing plants are the woolen mills of East Brady. Railroads, aggregating forty-three miles, traverse this division of the watershed, including the Allegheny division of the Pennsylvania following the east bank of the river and branches of the Baltimore and Ohio and of the Bessemer and Lake Erie in the territory west of the river. There are but two public water supply systems, namely at Parker and East Brady. The Parker supply is derived from the river and passes through a filter. The East Brady supply is derived from a spring and a drilled well.

Domestic sewage pollution is contributed by an urban population estimated at 3,370. The numerous oil wells constitute an important polluting factor. Of the twenty-nine existing coal mines, three require pumps to dispose of their drainage and discharge sulphur impregnated water at an average combined rate of about 560 gallons a minute. The remaining mines have natural drainage discharging 1,400 gallons a minute. Some pollution exists at the woolen mills at East Brady.

Parker, Armstrong County, is a city of the third class, probably the smallest city in Pennsylvania, its population being about 1,300. In 1900, its population was 1,070, in 1890 it was 1317, in 1880, it was 1835 and in 1870 it was 7,000. It was incorporated in 1872, at which time it was a very active oil centre and as the oil excitement abated, the population decreased. The city is on the western shore of the Allegheny River on a low strip of land along the bank, back of which rises a precipitous bluff, the city boundaries including a portion of the table land at the top as well as the low land along the river. Its industries at the present time comprise the Thomas Whitman Glass Company, employing about 110 persons, the Parker Specialty Works, employing about seven, and a pumping station of the Standard Oil Company at the mouth of Bear Creek at the lower end of the city. Water is supplied by the Parker City Water Company, a corporation deriving its supply from a plank crib in the Allegheny River some distance from shore. The water was formerly strained and partially clarified in a small "filter" and thence delivered to four tanks in the higher parts of the town, whose capacities are from 32,000 to 40,000 gallons each and distributed through a system ranging in size from two to four inches. The so called "filter" was not adequate properly to protect the consumers in view of the polluted character of the river at this point and a modern filter plant has been installed by order of the Commissioner of Health. There are about 1,000 consumers and the per capita rate is about sixty gallons a day. Many private wells supply the remaining people. The Standard Oil Company derives a private supply from the river at the pumping station, for use in the boilers. The city has no public sewer system and owing to the unsanitary conditions arising from the discharge of a large number of private sewers on the slopes and into the waters of the river and several runs, the city authorities were compelled to build some public sewers. Cesspools are largely used, in many cases endangering private wells, and kitchen wastes and sewage are frequently discharged into the street gutters. Practically the entire population of 1,500 persons contributes domestic sewage to the river. The industrial wastes are of little or no importance.

It was on January 28th 1911, that the State Department of Health took charge of the control and supervision of a typhoid fever outbreak at Parker City. At the end of February there had been eighty-four cases and five deaths resulting from the pollution of the public water supply by typhoid infection discharged into the river at points above the water works intake within the city and possibly from the pollution of the river water at other points above. Temporary apparatus was set up in the pumping station and water in the filtered water chamber was treated with hypo-chlorite of lime. This treatment was continued by the water company under the direction of the De-

partment until the water company had prepared plans for a modern filtration plant, obtained approval of the same and erected the filter plant and put it into operation.

In March 1911, the Commissioner of Health issued a decree relative to sewerage to Parker City which contained among other things the following discussion:

"Although until recently little interest has been taken in improving sanitary conditions, people now have waked up to a better realizing sense of the danger of maintaining private sewer outlets into the river above the town's water works intake.

The extremely unsanitary conditions at the foot of the bluffs is due to the discharge of sewage above and should be stopped. During the summer months Church Run is nearly dry and the sewage discharged into it from private dwellings forms pools and pollutes the banks until rain comes and washes it away. Cess-pools and abandoned wells in proximity to the private wells from which water is drawn for drinking are used as receptacles for sewage thus imperiling the health of those who drink the water drawn from neighborhood wells. What is needed in Parker to prevent other epidemics, is the discontinuance of the discharge of sewage into State waters, except, possibly, the river at one point below the water works intake, the abandonment of a number of wells on private properties, and more attention paid to the enforcement of health rules and regulations.

"From the city of Parker down stream to the mouth of the Allegheny River at Pittsburgh, a large number of towns use the water for drinking purposes. At the borough of Kittanning about thirty-one miles down stream, approximately six thousand people rely upon the river for the supply. At the borough of Ford City, about ten miles further down stream, the river water is served to over four thousand people, after having passed through a gravel crib in the bed of the river. At Freeport, fifty-three miles below Parker City, filtered river water is supplied to the inhabitants, and from Freeport to Pittsburgh, a distance of about thirty miles, in the neighborhood of about six hundred thousand people rely upon the river water for all domestic purposes.

"So not only is public health in Parker imperiled by the city's own sewage, but the health of the public in towns farther down stream is more or less menaced by Parker's sewage. It is the State's policy to preserve the purity of the waters of the Allegheny and plans must be devised by the towns along its banks to ultimately discontinue the discharge of sewage into the river.

"At Parker, one of the first things to be done is to construct an intercepting sewer along the river flats to take the flow from all private sewers now emptying into the river above the water works intake and to convey this sewage into the river below said water works intake. This should be done in such a manner that this intercepting sewer shall be a part of the complete system of sanitary sewerage for the entire borough and as a part of a plan for the ultimate treatment of the town's sewage. To carry out such an idea means the employment by the city of an engineer skilled in the design and construction of such works and when the plans are prepared, they should be submitted to the Commissioner of Health for approval. If the local authorities neglect to proceed in this manner, then the State will be forced to compel every owner and user of a private sewer to discontinue the discharge into State waters and to dispose of the sewage at his own proper cost and expense. Probably this will mean the building of large water tight vaults at each property and the pumping out of the contents at regular intervals and its cartage away to some more extended area where it can be filtered and purified without endangering public health. This would mean also that properties connected to the storm drains must sever the connection for any sewage.

"The State has compelled the water company to build a modern water purification plant and plans for this improvement are now before the Department for acceptance.

"In considering a comprehensive sewerage system and site for disposal works, the Department will be glad to advise and consult with the borough's expert. In the matter of the selection of a site for the disposal works, the choice is limited, owing to the close approach of the bluff to the river shore at the lower end of the city. It will probably be necessary to pump the sewage from the lower portion of the city to the disposal works whatever site is selected. It is also possible that the sewage from the upper districts can be delivered by gravity to the works.

"The discharge of sewage over the bluffs and into the runs must be discontinued. If the requisite money is not forthcoming to do this by a public system at first, then the cost must be assumed by the individual property owner. But in the consideration of the entire subject, the local authorities will find considerable aid to a conclusion in having in their possession plans for a comprehensive sewerage system with estimates of cost."

Karns City, Butler County, is a borough with about 250 inhabitants, situated on both sides of Bear Creek about twelve miles

west of its point of discharge into the Allegheny River at Parker. The borough embraces 225 acres and during the oil excitement had a large population and gave promise of being a large town. The Starlight Refinery a small establishment and the Pennsylvania Refining Company, the latter employing five men, appear to comprise the industries of the town. There is no water supply system. Privies and one or two cesspools form the only means of domestic sewage disposal other than one six inch sewer serving a family of two. There are several privies on the bank and overhanging Bear Creek. Kitchen waste is generally discharged to the ground. The Starlight Refinery has a six inch sewer and the Pennsylvania Refining Company a ten inch sewer into Bear Creek, discharging oil waste and grease. As these refineries use sulphuric acid it is probable that some of this reaches the stream.

Petrolia borough lies about eight miles southwest of Parker on Bear Creek. It is an oil town with a population of about 500 at the present time, but formerly it was much larger. The industries are small, consisting of a boiler shop, a machine shop, and a "chopping" mill with but few employees. There is no public system of water works, water for domestic uses being derived from private drilled wells and springs there being forty three drilled wells, two dug wells and twenty-one springs in use in the borough. There is no public sewerage system. Many of the houses, however, have individual sewers discharging kitchen wastes to the highways or to Bear Creek, and there are two or three small sewers discharging sewage from individual properties into the creek. Privies are in general use.

Fairview borough, Butler County, (Baldwin P. O.) with a population of about 220, is located on a high divide between two branches of Bear Creek at a point some seven miles from its mouth. It has no public water system, private drilled wells being in general use with a few dug wells and springs. The town has no sewers, public or private, privies being common. Kitchen wastes are discharged to the ground or to cesspools in such a way as to cause little or no nuisance.

Bruin borough, Butler County, with a population of 600 is located on Bear Creek about six miles from its mouth. The borough has practically no industries except the production of oil, being the centre of an active field. Water for domestic purposes is obtained from springs and wells, there being twenty-eight drilled wells, four dug wells and eight springs in use in the borough. Kitchen waste generally is discharged to the highway or creek. There are no sewerage facilities except a few individual private sewers to the creek for the greater part discharging only kitchen waste.

Queenstown borough, Armstrong County, is a small rural community two miles west of the Allegheny river at East Brady with a population of about seventy-five. Water for domestic purposes is obtained from a number of drilled and dug wells and eight or ten

springs. There are a number of private sewers discharging mainly kitchen waste to Chrystie Run, a tributary of Sugar Creek, and one private sewer discharging into an abandoned coal mine. There are no industries, the town being strictly residential in character.

East Brady, Clarion County, is a borough of about 1,300 population situated on the east bank of the Allegheny River about four miles above the mouth of Red Bank Creek. The citizens are largely employed at coal mine operations in the vicinity or by the Pennsylvania Railroad Company. Other industries include the Valley Yarn Mill, East Brady Woolen Mill, a planing mill, and a grist mill. The East Brady Water Company supplies about 900 consumers with water for domestic purposes. This water is derived from a spring on the mountain side and formerly, during dry weather, it was necessary to augment the supply by pumping from a driven well that was impregnated with salt, rendering it unsuitable for drinking purposes. This was abandoned by order of the Commissioner of Health and a new well substituted. There are a large number of drilled wells and two dug wells serving some 400 persons. The sewers of the borough, twelve in number, all private, range in size from four to ten inches and aggregate a total length of 6,050 feet, serving a population of about 200. All discharge on the river bank several feet below low water level. On October 3rd plans for a comprehensive sanitary sewerage system to receive also roof drainage with three outlets to the river and serving the entire population were submitted to the Department and a permit for their construction was issued on October 11th, 1906 subject to certain conditions and stipulations, among them being the exclusion of roof water, the abandonment of private sewers and the preparation of a plan for the interception and treatment of all of the sewage of the borough.

(b) *Clarion River Drainage Area.* The Clarion River has two principal sources, the East and West Branches, which rise in numerous rivulets in the south central part of McKean County. The West Branch heads in a deep wooded ravine surrounded by hills, the tops of which are cultivated, and flows in an almost due southerly direction to Johnsonburg. The East Branch heads in a deep narrow boulder covered valley, surrounded by a desolate country partly covered with second growth, and has a general southwesterly direction to its confluence with the West Branch at Johnsonburg. This stream is clear above Instantter, but from there down is of a dark, cloudy green color. It is badly stained by drainage from chemical works, tanneries, and many oil wells. Ripples are numerous throughout its course as it is generally very shallow, and at its confluence with the West Branch, it is about forty feet wide. Below Johnsonburg the country is bleak, desolate and strewn with boulders and the course of the river is very sinuous. From the junction of these two

branches the Clarion River flows nearly due south for two miles and a half, where it makes an abrupt turn to the west and from this point the general direction of its course is southwest to a point five miles below Ridgway. Here it turns sharply to the north of west and follows this direction to Hallton in the northern part of Springcreek Township. It then turns to the southwest flowing with many bends and turns between Forest and Jefferson counties and through Clarion County to its confluence with the Allegheny River immediately below Foxburg.

Elk Creek, which enters the Clarion River at Ridgway, coming from the east, flows through a deep, narrow gorge and is bordered on both sides from the greater part of its course by waste lands. At its mouth Elk Creek is about fifty feet wide and its waters are inky black, due to tannery wastes and mine drainage. The Clarion River at Johnsonburg presents an unusual feature, the west side of the river being fairly clear while the east side is badly stained by paper mill wastes. At Ridgway the Clarion River is about 150 feet wide and its waters a dirty dark brown color, due to the waste from numerous tanneries which enter both the main stream and its tributaries. Big Mill Creek heads in a hilly waste wilderness in northern Elk County and flows in a due southerly direction through a country fairly well covered with second growth timber to its confluence with the Clarion River below Ridgway. Little Toby Creek rises in the south central part of Elk County and the northeastern part of Jefferson County and flows in a circuitous course to its junction with the Clarion River about eight miles below Ridgway. This stream flows through a deep rolling valley with high hills on either side. In the northern part of the valley there are a few farms in the bottom lands but for the most part it is a barren country. At its head waters Little Toby Creek is clear and swift but at Brockwayville the stream is about forty feet wide, rather sluggish, and stained yellow by mine drainage. Many small coal mines drain to the Clarion River through Deer Creek and its tributaries. The valleys of this creek and its tributary, Paint Creek, are hilly, about one half being wooded and the remainder farmed.

Along the Clarion River and its tributaries in Elk County the principal prominent topographic features are the scalloped ridges or knobs, the summits of which range between 300 to 600 feet above the bottom of the valleys. The steepest slopes are generally found near the base of the hills. Back from the streams the surface is cut up into valleys and small elevated plateaus. The surface of the ground bordering the river in Clarion County is rough and rugged with steep descents to water level, often precipitous. Receding from the main course between the dividing ridges, the country becomes less rugged, though still decidedly steep. As the stream nears its confluence with

the Allegheny River it winds slowly through its canyon like gorge while beyond spread a series of sharply cut mountain ridges, wild and rugged, separated by deep precipitous gorges through which its tributaries flow. This territory bordering the Clarion is covered, generally speaking, with a rough second growth of timber with small clearings and an occasional oil derrick. South of the river there is much excellent farming land made from the disintegrated shales and friable sandstones; but north of the Clarion, sandy and cold clayey soil covers most of the surface, and this soil is usually quite poor.

The slope near the headwaters of this river is rapid but from Cooksburg on the Jefferson and Forest County line to its junction with the Allegheny River below Foxburg, the average rate of fall is seven feet to the mile. A gauging of this stream by the Pennsylvania Water Supply Commission at Clarion on September 26, 1908, showed, the minimum flow to be 119.5 second feet.

Rainfall records are available for Ridgway near the headwaters, Clarion, and Parkers Landing on the Allegheny near the mouth of the Clarion River. The annual precipitation in inches follows:

Town.	Years of Complete Records.	Number of Years Covered.	Maximum.	Minimum.	Mean.
			inches.	inches.	inches.
Ridgway,	8	9	44.71	29.92	38.37
Clarion,	9	14	58.56	38.41	46.81
Parkers Landing,	21	22	57.29	32.52	43.04

The Clarion River drains an area of 1,175 square miles including parts of McKean, Elk, Forest, Jefferson, and Clarion counties and has been invaluable to the lumber interests of these counties. This stream has been declared a public highway. From the confluence of the Clarion and Allegheny Rivers, the distance to the mouth of the Allegheny River is 86.1 miles and to the source of the Allegheny about 222 miles.

The total population of the Clarion River basin is 67,110 divided into: urban 25,790, rural 41,320. The rural population is approximately thirty-five to the square mile.

The three largest towns in the basin are Ridgway, St. Marys, and Johnsonburg, all of which are in Elk County. Johnsonburg and St. Marys are industrial communities, there being pulp and paper mills, chemical works, and tanneries in both towns. Large quantities of liquid wastes from these establishments are discharged into the stream, and pollute it to such an extent that fish have been practically exterminated.

The waters of the Clarion River and its tributaries are used at a number of points for the development of power to run small industrial plants as noted below :

Elk County.

Mead Run at Shawmut.
Clarion River at Ridgway (80 H. P.)
Big Mill Creek at near Ridgway.

Clarion County.

Paint Creek at Lickingsville.
Piney Creek at Limestone.
Licking Creek at Sligo.

The industries of this region are varied, consisting principally of agriculture, coal production, oil and natural gas operations, beside which there are a number of industrial plants mainly depending either now or originally upon the vast timber resources, especially of the territory around the head waters. Chemical plants, tanneries, paper mills, and glass plants are the most important of these. The tanneries are all on the watershed above Clarion and include plants of the Elk Tanning Company at Arroyo, Portland Mills, Instanter, Wilcox, and two plants at Ridgway, the "Ridgway" and the "Eagle Valley," beside which there is the plant of the St. Marys Tanning Company at St. Marys, and the Rolfe Tanning Company at Johnsonburg. Chemical plants for the manufacture of wood alcohol, acetate of lime, and charcoal are located as follows, all being above Clarion :

St. Marys,	M. J. Corbett Chemical Company.
Dahoga,	McKean Chemical Company.
Glen Hazel,	Wright Chemical Company.
Straight,	Lackawanna Chemical Company.
Straight,	Straight Chemical Company.
Maxwell Run,	Clawson-Fiske Chemical Company.
Spring Creek,	Clawson-Fiske Chemical Company.
Hutchins,	Pen Chemical Company.
Sargeant,	Otto Chemical Company.

The glass plants noted are the Pierce Glass Company of St. Marys and the Brockway Machine Bottle Company of Brockwayville. At Johnsonburg are the paper, soda pulp, and sulphite pulp mills of the New York and Pennsylvania Company and the Highland Paper Company, both controlled by the same interests. On the Clarion River watershed above Clarion there are forty-one coal mines and below Clarion there are seventeen mines. Near Edenburg on Canoe Creek, a tributary of the Clarion River some distance below Clarion, is located the nitro-glycerine plant of the Ellis Hall and Sons Company.

Lumber and coal mine operations have resulted in the construction of a large number of railroads in the upper portion of the watershed; but chiefly owing to the topography of the territory adjacent thereto, the greater portion of the main stream is not followed closely by a railroad. This is not true of its upper portion, however, where the stream and its principal tributaries have generally one and sometimes two railroads following their banks. The railroads are represented by branches of the Pennsylvania; Buffalo, Rochester and Pittsburgh; Erie; Pittsburgh, Shawmut & Northern; Baltimore and Ohio; Tionesta Valley, and a number of small roads. The total trackage amounts to upwards of 300 miles.

The Clarion River is not used as a source of public water supply. At only one point, Clarion, there was an emergency intake. The Department compelled the abandonment of it. In general, water for domestic purposes is derived from wells and springs. Four boroughs are supplied by water companies, namely, Johnsonburg, St. Marys, Brockwayville, and Clarion; three have municipal supplies, namely, Ridgway, Edenburg and St. Petersburg. Industrial supplies are derived from the Clarion River at Johnsonburg by the New York and Pennsylvania Company and the Rolfe Tanning Company, from Elk Creek at St. Marys by the Corbett Chemical Company's plant, from the river at Ridgway by the Elk Tanning Company and from Licking Creek at Sligo by the Sligo Fire Brick Company. The New York and Pennsylvania Company uses about 25,000,000 gallons daily, of which it has been found necessary to filter 10,000,000 gallons.

Johnsonburg, St. Marys, Ridgway and Clarion have sewer systems of greater or less extent. It is estimated that a population of 21,365 persons contribute domestic sewage to the stream above Clarion and 4470 persons below Clarion, making a total of 25,835 persons polluting the stream with sewage.

By far the most important pollution of the streams comes from the industrial operations, especially the chemical plants, tanneries, paper and pulp mills, and coal mines. The chemical plants enumerated above discharge very extensive wastes into the stream.

In many of the streams having water suitable in the basin tributary to the Clarion River, young trout have been placed by the State Fish Commission and the upper waters of the West Branch of the Clarion River has been stocked with bass and pike perch.

In Table XXXVIII is given a chemical analysis made of the streams near Ridgway, by the chemist of the Elk Tanning Company, and also mineral analysis of the Clarion River at Johnsonburg and Clarion made at the laboratories of William B. Scaife and Sons Company, Pittsburgh.

TABLE XXXVIII.
Chemical Analyses of Waters in Clarion River Basin.
Parts per Million.

Determination.	Clarion River at Ridgway, Dec., 1909.	Elk Creek at Ridgway, Dec., 1909.	Whetstone Run, Brockwayville, Dec., 1909.
Appearance,	Turbid.	Turbid.	.....
Color,	Red Brown.	Yellow Brown.	.....
Reaction,	Neutral.	Neutral.	.....
Total Residue,	1,870.00	365.66	.....
Loss on Ignition,	800.00	95.00	.....
Chlorine,	255.52	59.98	2.560
Free Ammonia,	0.250	0.840	6.010
Album. Ammonia,	0.170	0.440	0.005
Calcium Oxide,	270.00	.....	.....
Sulphates,	170.01	.....	.....
Total Solids, .....	.....	.....	27.906
Mineral Solids, .....	.....	.....	12.0
Organic Solids, .....	.....	.....	15.9

TABLE XXXVIII.—Continued.

Determination.	Clarion River.		
	at Johnsonburg, Oct., 1906.	at Johnsonburg, Nov., 1906.	at Clarion, Dec., 1909.
Volatile and Organic,	18.8	11.1	41.0
Silica,	4.3	3.4	5.4
Iron and Al. Oxide,	2.6	2.6	4.3
Calcium Oxide,	10.3	13.6	51.3
Magnesium Oxide,	5.6	3.8	13.3
Sodium Oxide,	1.0	3.8	21.2
Sulphuric Anhydride,	6.8	5.5	53.6
Carbonic Anhydride (Fixed),	4.2	7.5	20.7
Carbonic Anhydride (Free),	9.4	9.4	3.8
Chlorine,	8.4	11.1	32.5
Nitric Anhydride,	4.3	Trace.	.....
Calcium Carbonate,	9.7	17.6	47.9
Calcium Sulphate,	11.6	9.2	69.5
Magnesium Sulphate, .....	.....	.....	26.2
Magnesium Chloride,	9.4	9.1	10.9
Magnesium Nitrate,	6.8	.....	.....
Sodium Chloride,	2.1	7.0	40.0
Alkalinity,	9.4	17.1	47.0
Total Solids,	64.3	69.0	233.1
Suspended matter,	9.4	7.7	4.3
Free Carbonic Acid,	9.4	9.4	3.8
Incrusting Solids,	62.2	53.0	158.3
Non-Incrusting Solids,	2.1	7.0	49.0

Johnsonburg, Elk County, population 4,200, is a borough situated in the central part of the county at the fork of the East and West branches of the Clarion River. It is essentially a manufacturing community, the paper and pulp mills of the New York and Pennsylvania Company being largely responsible for the growth and prosperity of the town. At their mills in the town and in their wood operations in the vicinity this company gives employment to about 1,450 persons. Beside the large paper and pulp mills of this company, there is the extensive tannery of the Rolfe Tanning Company. The citizens of the borough obtain their drinking water partly from individual wells and neighborhood springs and partly from the Johnsonburg Water Company. It is estimated that about 2,700 persons are supplied by the water company and about 1,500 by drilled wells and springs. Owing to the topography of the borough, there are one low pressure and two high pressure water districts. The low district is small and is supplied by gravity from a storage reservoir on Silver Creek. The pressure may be increased in cases of emergency by the use of pumps at the works of the New York and Pennsylvania Company. The smaller of the two high pressure districts comprises a few dwellings which are supplied with water from springs. The other high pressure district comprises the principal part of the town, the water being obtained from Powers Run and from springs in its valley. The water is pumped to a reservoir on the hill above the town and thence delivered by gravity. Typhoid fever has been prevalent in Johnsonburg for some years past. Reports indicate that in 1904 there were 75 cases; in 1905, 35 cases; in 1906, 28 cases; in 1907, 42 cases

and in 1908, 24 cases. One of the springs known as Murray Spring, used quite extensively by the residents of the neighborhood, is so situated as to be extremely liable to contamination from yards and privies on the slope above it, and two cases of typhoid occurred on one of these properties just prior to an outbreak of typhoid among the users of this well. The Silver Creek watershed appears, from an investigation, to be practically uninhabited. An examination of the drainage area of Powers Run in the summer of 1905 showed several sources of pollution, including a settlement of ten houses with privies and pig pens, barn yards, and lumber camps, usually without sanitary accommodations and containing from 400 to 800 persons in all. An epidemic of "bowel complaint" in one of these camps preceded by about four weeks an outbreak of dysentery in Johnsonburg. On November 9th, 1905, the Commissioner of Health issued a permit to W. E. Zierden to supply a church, school and ten dwellings with water from a driven well. The New York and Pennsylvania Company derives a private, industrial supply from the Clarion River, using about 25,000,000 gallons a day at the two plants. Because of the industrial pollutions from chemical plants and tanneries above Johnsonburg, the Paper Company has found it necessary to install a mechanical filtration plant in which it purifies about 10,000,000 gallons daily of the water used for industrial purposes. There are four sewer outlets from the borough, two into the river and two into runs receiving roof and cellar drainage as well as sewage. Many properties are not connected with the sewers, using loose earth privy vaults which frequently overflow, the contents being washed by storms into the street and alley gutters. Slops and wash water are noticeably discharged into street gutters. Probably 4,000 persons contribute sewage pollution to the river. Decrees were issued by the Commissioner of Health on April 13, 1907, and June 27, 1907, allowing the construction of certain sewerage extensions and requiring the preparation of plans for a comprehensive sewerage system including the exclusion of storm water and collection of all the sewage and its ultimate purification at sewage disposal works. The tannery wastes from the Rolfe Tanning Company's plant are a very considerable source of pollution. The tannery has a capacity of 350 green hides a day, using both extract and bark in the tanning process, and lime for dehairing, and also about 350 pounds of sulphuric acid daily. The wastes are typical of tanning operations. The paper and pulp mills discharge very extensive wastes into the river. These plants are known as the "Highland Mill" of the Highland Paper Company and the "Clarion Mill" of the New York and Pennsylvania Company, both being controlled by the same interests. The Highland Mill is a soda fibre plant with a daily capacity of thirty-seven to forty tons of soda fibre. The "Clarion Mill" not only makes its own soda fibre and sulphite pulp, but also puts out daily from eighty to ninety tons of paper and twenty to thirty tons of soda fibre.

The capacity of the two soda pulp mills combined is 115 tons a day, and of the sulphite pulp mill thirty tons a day. The wastes from the soda mills are said to contain a small percentage of lignin, some carbonate of soda, lime water, and a trace of chlorine, the waste waters containing probably not over 3,000 pounds of soda a day. Wastes from the paper mill are said to contain a small percentage of alum and rosin size and, on rare occasions, coloring matter. The sulphite pulp mill wastes are of a reddish brown, changing to a dark purple and are largely organic, putrefying and giving off bad odors.

The sewerage decree of April, 1907, issued by the Commissioner of Health to Johnsonburg borough contains the following discussion:

"The situation in Johnsonburg from the standpoint of the interests of the public health, not only of the citizens of the borough but the public in general who may be affected through the various mediums of disease transmission from a focus of infection such as does now and will continue to exist in Johnsonburg until proper sanitary measures are intelligently and vigilantly enforced, calls for prolonged consideration, prudent conclusions and action.

"Typhoid fever and other water borne diseases are far above the normal rate. During the first eleven months of one thousand nine hundred and six, there have been twenty-eight cases of typhoid fever reported. Diminution in this rate cannot be expected, but a very great increase is possible so long as sewage is improperly disposed of in the borough and the surface and ground water supplies used for drinking purposes are poisoned by pathogenic material. The first efforts of the borough authorities should have for their object the protection of the lives of the people and practical measures must necessarily call for the expenditure of moneys. Last year the assessed valuation of the borough is reported to have been four hundred and thirty-three thousand three hundred and eighty dollars, which fixes the statutory limitation of bonded indebtedness at thirty thousand, three hundred and sixty-six dollars. If, as reported, there are on hand five thousand and thirty-six dollars with which to pay off the old bonds, then it would appear that the borough could issue further bonds to the amount of fifteen thousand, eight hundred and seventy-two dollars. It is understood that there is cash on hand to the amount of about forty-five hundred dollars, and that for general municipal purposes it is possible for a fund of about twenty dollars to be raised.

"Therefore, any serious mistake in the expenditure of funds might very materially handicap the borough in carrying forward a complete plan for the betterment of general sanitation in Johnsonburg.

"The proposed sewer will stop the backflooding of a few properties only. The plan submitted does not show the size or grade of the proposed sewer, nor does it appear to have been designed with any clear conception of the work it should perform now and in the future. It is possible when sewage disposal works are built, as they must be, that the proposed outlet sewer would not be at all adapted to the requirements of the town then. Furthermore, while there are known to be in existence plans and profiles of the existing sewers and of additions that must be made in the future to the system, yet the borough has never submitted such plans or a correct report of its sewer system, giving the Department reliable information called for in this connection. In fact, the borough's sanitary affairs have been certainly neglected or conducted in a dilatory manner.

"The borough ordinance places the matter of all nuisances in the hands of the local board of health. Privy vaults, cesspools, etc., unless water-tight shall not be dug or permitted to remain within one hundred and fifty feet of any well or spring used for drinking or culinary purposes, and yet it is obvious that this regulation has not been enforced. Further, in no case shall privy vaults be less than five feet deep. Earth privies and closets with no vault, pit or depression must be daily supplied with ashes or absorbents and contents completely removed monthly, and all vaults, cesspools, etc., shall be cleaned out at least once in the spring not later than May fifteenth and at least once in the fall not earlier than October fifteenth. Besides, such structures shall be disinfected weekly by a solution to be approved by the local board of health. Still further, no offensive or deleterious waste or refuse shall be allowed to accumulate on premises or to be thrown or allowed to run into any public waters, streets, etc.

"In spite of these regulations and the powers of the local authorities and the prevalence of disease in the borough, it seems that systematic emptying of privy vaults has been neglected. Generally work of this kind having been performed only once in the past twelve years.

"There is a provision whereby all buildings on the line of a sewer shall be connected with the sewer within thirty days from notification by the borough council, subject to fine and cost of said connection being made by the superintendent of sewers.

"This provision has never been enforced generally. Where sewers are not provided or used, tight masonry vaults should be constructed under new borough ordinance prescribing dimensions and manner of construction to the end that the overflowing of them or surface wash of the contents of these receptacles shall be absolutely prevented. The borough ordinance provides for a superintendent of sewers, but the appointment by the burgess has never been made so far as the Department is informed. This officer should be appointed."

In July, 1912, the Commissioner of Health approved plans for a comprehensive sewerage system and for a site selected for sewage disposal works.

St. Marys, Elk County, population about 6,400, is a borough situated near the headwaters of Elk Creek about one mile from the eastern divide of the Allegheny watershed. Elk Creek from this point flows a distance of nine miles nearly due west, entering the Clarion River at Ridgway. It is a manufacturing town with a number of important industries, among which are the M. J. Corbett & Company chemical plant, the Pennsylvania Stave Company, the St. Marys Sewer Pipe Company, the Spees Carbon Manufacturing Company, the Hall & Kaul Lumber Company, the St. Marys Tanning Company, the Pierce Glass Company, the Stackpole Battery Company, the Standard Wood Company, the Pennsylvania Fire Proofing Company, and the shops of the Pittsburgh, Shawmut & Northern Railroad. The public water supply is furnished by a private corporation known as the St. Marys Water Company, whose sources of supply are mountain streams, Silver Creek and Laurel Run, both tributary to Elk Creek, and Wolf Lick Run tributary to the Sinnemahoning. These streams are fed by copious springs, the Silver Creek supply being augmented by three drilled wells. The use of the additional source of supply known as Silver Lake Run and the extensions of the Company's mains were approved in a permit issued by the Commissioner of Health to the St. Marys Water Company on May 4th, 1908. It is reported that 2,000 persons or more obtain drinking water from springs and dug wells. Some of the industrial plants have private driven wells. The chemical plant of the M. J. Corbett & Company has an industrial supply for condensing purposes, taking about 1,150,000 gallons of water a day from Elk Creek. In 1907 it was reported that there was but one public sewer in the borough, a twelve-inch drain serving about twenty families and five private sewers with forty-six connections beside a private sewer from the tannery which is said to have twenty or more house connections. Many individual properties also have drains discharging directly into the creek or its small tributary runs, and shallow earth privies abound. It is reported that sink and wash water, and in some cases water closets, discharge into the street gutters and that there were over 500 buildings whose wastes are disposed of in a way to menace public health. A comprehensive plan for sanitary

sewers throughout the borough has been adopted, the Commissioner of Health having issued a permit therefor on June 6th, 1907. The plans then submitted include purification works and the permit issued contemplates the construction from time to time of such sewers as may be needed and the erection of the sewage disposal works at such time as the interests of the public health may so demand. The only industrial plants discharging wastes of sanitary importance are the tannery and the chemical works. The M. J. Corbett chemical company manufactures wood alcohol, acetate of lime, and charcoal, using seasoned hardwood, and two or three carloads of lime a month. The waste liquid from the stills, characteristic of these plants, is discharged into the stream along with about 1,150,000 gallons of water daily used for condensing purposes. The St. Marys Tanning Company's tannery operated by Kistler, Lesh & Co., of Lock Haven, handles 320 green hides a day, using both extract and bark for tanning and lime for dehairing. Some sulphuric acid is also used. Oil and gas operations of limited extent in this vicinity and extensive coal mines contribute characteristic wastes, the former being of small importance.

Ridgway, Elk County, population about 6,700, is a borough and the county seat. It is a manufacturing community, situated on the Clarion River at the mouth of Elk Creek. Its industries comprise the "Ridgway" and "Eagle Valley" tanneries of the Elk Tanning Company, the Ridgway Machine Works, the Russell Car & Snow Plow Works, a machine shop and foundry, dynamo and engine works, brick works, planing mill and the Clarion Extract Works of the Elk Tanning Company. An axe factory here has a water power installation developing 80 H. P. In the region around Ridgway natural gas is abundant, and oil is produced in limited quantities. Coal also is mined to some extent. The water works system is owned by the municipality. Its source of supply in the past has been a small dam on Gallagher Run, augmented by two drilled wells on its watershed. In dry seasons the wells alone were used. A typhoid fever epidemic in the spring of the year 1904 was attributed to pollution of the water in these wells. While the greater portion of the public is served with the public supply, drinking water is largely obtained from semi-public springs, of which there are between thirty and forty and about the same number of wells scattered throughout the borough. Several of these springs are used to supply a limited number of houses and in some cases industrial plants. Local outbreaks of typhoid fever have occurred from time to time among users of spring water and a number of springs were condemned. An epidemic, numbering over 300 cases, started in August, 1907. On September 5th, 1907, the Commissioner of Health issued a permit for an additional source of supply from Big Mill Creek and ordered the installation of a filter

plant for the treatment of this supply and the abandonment of all springs found to be suspicious, and also ordered the disconnection of all wells from the public system and the abandonment of the Gallagher Run Supply as soon as possible. On June 18th, 1908, the Commissioner of Health issued a subsequent permit approving plans for a filtration plant and requiring that the borough filter all of the water supplied to the town.

The public sewer system was built on a comprehensive plan and has six outlets, two into Elk Creek, fifteen and eight inches in diameter and four into the Clarion River, one eight inches, one fifteen inches and two twenty inches in diameter. One of the last named twenty-inch sewers is an interceptor about 6,000 feet long. No storm water is admitted to the system except from the roofs of buildings. There are a few unimportant storm sewers, but surface drainage is largely depended upon. There are also numerous private sewers with outlets into Elk Creek, Gallagher Run and small water courses. Eleven other sewers range in size from eight-inch pipe to two-foot culverts. Cesspools are practically unknown and where there are no sewers kitchen waste is thrown on to the ground or drained to street gutters. Excrement is deposited in loose earth vaults, of which there are hundreds in the town, mostly on the hillside and frequently above springs and wells, the waters of which they continually menace. Practically the entire population, directly or indirectly, pollutes the stream. On June 11, 1908, the Commissioner of Health issued a permit approving of the extension of the sewerage system of Ridgway in accordance with a comprehensive plan then submitted which involved the interception of all private sewers, and requiring the preparation of plans for a sewage purification plant. At the extract works of the Elk Tanning Company water is pumped from the river for condensing purposes and returned without added contamination. The Ridgway tannery of the same company discharges water from hide soakings, bleach water, and plumping water. At the "Eagle Valley" Tannery of the same company both bark and extract are used and lime is used for dehairing as well as acid in the bleaching process. The daily liquid wastes are water from hide soakings, lime water, and bleach water.

In July, 1908, in a decree issued by the Commissioner of Health to Ridgway borough, the following discussion relative to sewerage may be found:

"It is probably well within the facts to state that the typhoid fever epidemic of nineteen hundred and seven cost the community of Ridgway upwards of one hundred thousand dollars. The thoughtful citizens now realize the economy of the installation of sanitary methods of sewage disposal. Local sentiment is favorable to an improvement of the sewerage system and its extension to all parts of the town. The proposed plan is calculated to remove all poisonous matters from the vicinity of dwellings as quickly as possible and to discharge it into the river far below the borough and in order to accomplish this as speedily as possible it is purposed to incorporate the existing private sewers into the system.

"While this is satisfactory as a temporary expedient, it should be temporary only.

"The Clarion River rises in McKean County and the summit of the eastern boundary of the stream's area is the divide between the two great basins of the Susquehanna and the Allegheny River systems. The watershed above Ridgway is about two hundred and eighty-five miles in extent, including Elk Creek. Most of the land is within Elk County, is hilly, largely deforested and interspersed with narrow steep valleys in the horizon of the Kittanning coal measures. Johnsonburg is the principal place in the territory above Ridgway on the river. In that town and above it are paper mills, tanneries and chemical works from which large quantities of trade wastes are emptied into the stream and pollute the waters. The State has required the borough of Johnsonburg to prepare plans of improved sewerage with a view to some other method of disposal of sewage than into the river.

"The borough of St. Marys is now constructing a new sewer system approved by the State Department of Health, which system was designed in connection with a purification plant, to be erected later.

"Below Ridgway the river pursues a general southwesterly course to the Allegheny River, a distance of seventy-seven miles. In many places its banks are high and precipitous and the region traversed is sparsely populated and rural. So far as the Department knows, the waters are not used for drinking purposes except at Clarion, where there is an emergency intake. The citizens of this town complain that at times the pollutions of the river cause a nuisance and that fish life is practically extinct. The water company obtains its supply from drilled wells along the river and it may be never necessary to resort to the stream again for a supply. Nevertheless, this is not a sufficient reason why the river should be used as an open sewer. It is the policy of the Commonwealth to preserve the virgin purity of its mountain streams as a public resource.

"The borough of Ridgway is not financially able to erect a sewage purification plant immediately. However, the sewers should be built and extended in contemplation of treatment works at no distant date. This requirement demands the exclusion of storm water from the sewers because it is not practicable to purify the great bulk of mingled house sewage and surface drainage.

"It is known that many of the private sewers are faulty, they serve as rain water drains and the public health demands their overhauling and reconstruction and in some instances entire abandonment. How many of them are suitable when repaired and provided with inspection manholes to be permanently incorporated into the borough sewer system can only be ascertained by critical examination. Without hesitation it may be concluded that the stone culverts and old water courses should be absolutely abandoned as carriers of sewage. They should be reconstructed under modern methods and be used exclusively for storm water and other pipes should be provided for sewage.

"Owners who have been to considerable expense in laying down the private sewers or in connecting their properties to such sewers will be loathe to undertake any further expense. There being such a large number of private sewers in the borough, approximately fifty per cent. of the population being served thereby, and the universal discharge of kitchen wastes and sewage being a general public menace would suggest that the local authorities should provide the remedy. Nevertheless, upon failure of the borough to do this, it would be incumbent upon the State health authorities to deal directly with the individual in discontinuing the discharge of sewage into the waters of the State.

"The industrial wastes now emptied into the river total a large daily amount. This waste must eventually be treated and purified. Most municipalities afford a sewer outlet for such wastes, as being most economical and satisfactory policy for the community. This is an added reason why the borough should take up the problem and afford sewerage facilities to everybody.

"When the sewer system shall have been completed and all sewage shall have been delivered to the outfall proposed, it will be found that the manufacturing wastes may distinctly characterize the sewage and require peculiar facilities for purification.

"All overhanging privies on banks of streams or the mill races should be at once removed, all public and private sewers to the streams should be discontinued as soon as practicable, the existing sewers should be overhauled and some of them abandoned, discharge of sewage and kitchen drainage into street gutters should cease, storm water should be excluded from the sewers, the sewer system should be extended as rapidly as possible and plans for sewage disposal works should be submitted within a reasonable time."

Brockwayville, Jefferson County, population about 2,000, is situated on Little Toby Creek near the northeastern border of the county. Its industries are small and include the Brockway Machine Bottle Company's glass plant, a macaroni factory giving employment to about fifteen persons, a handle factory, and a tool factory, each with about half a dozen employees. Coal mining is the dominant interest

of the borough and the surrounding region. Many of the coal workings are exhausted and the future of the industry in this vicinity is problematical. Water is supplied to the public by the Brockway Crystal Water Company, deriving its supply from Whetstone Run, a mountain stream with a wooded and practically uninhabited watershed. It is a gravity system and used by about three-fourths of the population, the remainder depending upon wells. The same company supplies some 250 persons outside of the town, including the adjoining village of Crenshaw. The borough has no public sewer system but there are some twenty-three private sewers discharging sewage into the creek, a part of them serving several families. Privies are in general use, some of them being on the bank of the stream. There is a large number of cesspools receiving kitchen waste, but much of it goes to the ground or by individual drains to the creek. There is no important pollution from industrial wastes.

Strattanville, Clarion County, is a borough with a population of 300 and is situated on a ridge above Stratton Run about three miles east of Clarion, the county seat. Although but two miles from the Clarion River, at a point some five miles above that borough, its drainage goes to Stratton Run and thence to Piney Creek, which enters the Clarion River some distance below Clarion. Its industries are insignificant. The inhabitants derive water from individual dug wells and four springs. There are no sewers, each property having individual outside privies, a few of them with board-lined vaults, and one property has a percolating cesspool. Kitchen waste is generally deposited to the ground, in two instances discharging to the highway.

Clarion, Clarion County, population 2,800, is a borough and the county seat. It is situated near the central part of the county on the Clarion River in an agricultural region. The surrounding territory produces coal, natural gas, and petroleum. A State Normal School is located here with an enrollment of 500 students and the industries comprise a glass bottle plant with about 110 employees and a cigar factory with about eighty employees. The borough is built upon the south bank of the river which here flows through a narrow gorge about 500 feet below the level of the town. About half the population obtains drinking water from wells and springs in the borough, the others purchasing water from the Clarion Water Company, which also maintains a fire service, the total daily consumption averaging about 200,000 gallons. The original source of the company's supply was the Clarion River, but this became so badly polluted, that recourse was had to McLains Run on the opposite side of the river. The discovery and development of a rich oil field on this watershed rendered this supply unsafe and wells were driven along the shore of the river. These yielded excellent water, but it

was still necessary to augment the supply by the use of McLains Run water and the Clarion River in extreme emergencies. An attempt was made to filter the McLains Run water, but the filters which were installed proved inadequate. On July 23rd, 1907, the Commissioner of Health issued a permit for the use of the driven wells and required the abandonment of the McLains Run and the Clarion River supplies or the installation of filters adequate to purify any waters derived from these sources. There are both public and private sewers in the town serving about three-fourths of the population, part of the sewers discharging into the Clarion River directly and others emptying on the hillsides.

Edenburg, Clarion County, population 750, is a borough situated in the northwest part of the county near Canoe Creek and about six miles from its confluence with the Clarion River. The town is an oil and gas centre of considerable importance and coal is abundant. The surrounding territory is well farmed. It has only minor industries, including a machine shop, a canning factory, a planing mill and a flour mill. On Canoe Creek, near the borough, there is the nitro-glycerine plant of Ellis Hall & Sons Company. There is a municipal water supply derived from a drilled well from which water is pumped to four tanks and thence distributed by gravity. Beside this supply there are some fifty drilled and thirteen dug wells and four springs in use. The only sewerage facilities are afforded by a number of private sewers; cesspools and privies are in general use, and the soil being of a clayey nature they frequently fill up and overflow. An outbreak of typhoid some years ago was traced to the use of dug well water. It is estimated that the sewage of about 275 persons reaches the stream, directly or indirectly. The daily wastes from the nitro-glycerine plant on Canoe Creek near the borough include some sulphuric acid. This waste, together with sulphur and salt water from springs and abandoned oil wells renders the water of Canoe Creek unfit for use by man or beast and constitutes a serious pollution of the Clarion River.

Curlsville, Clarion County, is a small borough with a population of about 130, situated at the head waters of Licking Creek, which enters the Clarion River at Callensburg. Three individual drains discharge kitchen waste and wash water to the highway or to Licking Creek. It is a rural community without industries, water works, or sewers.

Sligo, Clarion County, population 600, is a borough situated on Licking Creek about three miles from its confluence with the Clarion River at Callensburg. Its industries include the plant of the Sligo Fire Brick Company, a slaughter house, a water power flour mill, and two coal mines within the borough limits. There is no public water system, the inhabitants using private dug or drilled wells and

springs. The Sligo Fire Brick Company derives an industrial supply from Big and Little Licking Creeks. While there are no public sewers, some twenty-five pollutions have been noted, mostly consisting of the discharge of kitchen waste to highways or the creek. The slaughter house and hog pen in connection therewith produce unsanitary conditions in a small pond near the creek.

Rimersburg, Clarion County, population 850, is situated on a ridge in the southern part of the county near the divide between the Clarion River and Red Bank Creek watersheds. It lies at the head waters of Cherry Run about six miles from its confluence with Licking Creek at Callensburg and near the junction of the latter stream with the Clarion River. The borough appears to have no industries of note. The citizens derive water from private drilled and dug wells, and sewerage facilities are limited to two storm sewers eighteen and fifteen inches in diameter. Several properties are connected to these storm sewers discharging both sewage and kitchen waste into them. In some instances sewage and kitchen waste are discharged into the highway, but waste wash water generally goes to the ground.

Callensburg, Clarion County, population 250, is situated on high ground at the junction of Licking Creek with the Clarion River. It is reported that the borough has no industries. Its water supply is derived mostly from individual dug wells and there are no sewers of any kind, kitchen waste and wash water being discharged to the ground and privies in general use. The borough has excellent natural drainage.

St. Petersburg, Clarion County, population about 500, is situated on high ground about two miles east of the Allegheny River and Foxburg and just north of the Clarion. The production of oil has for many years been the principal industry of the inhabitants, though the oil supply is gradually diminishing. The borough has a municipal water works deriving its supply from springs and drilled wells said to be of excellent quality. The borough has no sanitary sewers and but one storm sewer about 100 feet long. Kitchen waste is largely discharged to the ground but in a number of instances by way of small drains to the highway. Considerable of the garbage from the borough is dumped at the outlet of this storm sewer, producing a nuisance at this point.

(c) *Typhoid Fever.* In Table XXXIX are given the typhoid cases reported by the local authorities of the different boroughs of this Division of the Allegheny basin for the years 1906 to 1912 inclusive.

TABLE XXXIX.

Typhoid Fever Cases Reported for the Section of the Allegheny Basin from the Clarion River to Red Bank Creek, 1906-1912, inclusive.

Town.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
Rimersburg,	3	1	0	2	0	2	3
Sligo,	2	1	2	1	2	0	2
Clarion,	0	0	11	10	2	5	4
East Brady,	0	0	3	2	1	0	1
Carlsville,	0	0	0	15	0	1	0
Edenburg,	0	3	4	4	3	2	0
Shippenville,	0	0	0	1	0	0	0
St. Petersburg,	0	0	0	0	0	0	0
Brockwayville,	2	0	0	0	0	0	2
Johnsonburg,	28	42	24	14	5	23	21
Ridgway,	47	222	36	28	26	2	1
St. Marys,	0	0	10	3	13	1	2
Parker,	20	20	0	0	17	76	3
Bruin,	1	0	0	0	1	0	0
Fairview,	0	0	0	1	0	0	2
Petrolia,	0	0	0	0	0	0	2

Section 12.—Red Bank Creek to Mahoning Creek.

(a) *Along Allegheny River.* From Red Bank Creek, the Allegheny flows in two long bends for a distance of about nine miles in a southeasterly direction, to a point where the Mahoning Creek joins it in the north central part of Armstrong County. Steep bluffs follow the river for most of this distance and they are largely covered with timber. Farms are scattered along the hillsides and on the uplands some distance from the stream. Coal mines are numerous throughout this section, most of them along the east bank. The total population of this portion along the Allegheny River is 1,550, all of which is rural.

Bass, yellow perch, pickerel, and pike perch have been placed in the river.

Coal mining forms the principal industry, although the oil production is of considerable importance.

The Allegheny Division of the Pennsylvania Railroad follows the east bank of the river through this section, a distance of nine miles. There are no other railroads within this area. The few towns are all very small and there are no public or industrial water supplies.

It is estimated that about 230 persons contribute sewage to the stream but coal mine drainage forms the principal polluting factor. In addition to a number of small workings, there are four mines of greater importance, the drainage from which is by gravity and amounts to approximately 555 gallons a minute.

(b) *Red Bank Creek Drainage Area.* Red Bank Creek originally bore the name of Sandy Lick, which name is still retained for its main branch coming from Clearfield County. The creek assumes the name of Red Bank at Brookville, where it unites with the North Fork.

Little Sandy Creek, the main tributary of Red Bank Creek below Brookville, is, at its mouth, about twenty-five feet wide and its valley is steep and wooded. From Brookville in the west central part of Jefferson County, Red Bank Creek flows in a general southwesterly direction to Summerville borough, where the stream turns southward and continues in its course until it leaves Jefferson County. From this point it forms the boundary between Clarion County on the north and Armstrong County on the south. Flowing southwest for about ten miles it swerves sharply to the south and again to the north, forming a long narrow loop, and then takes a westerly direction to its confluence with the Allegheny River just below Brady's Bend and sixty-five miles from Pittsburgh.

The headwaters of the North Fork are near the northeastern border of Jefferson County in a wide, barren, rolling valley, with only occasional farms along its banks. It flows in a general southwesterly direction to its confluence with Sandy Lick Creek at Brookville. Within the boundary of Pine Creek township, Jefferson County, the three principal streams, Sandy Lick, North Fork, and Mill Creek, unite to form Red Bank Creek. Sandy Lick rises in northwestern Clearfield County and flows in a general westerly direction to Brookville, passing in its course DuBois, Falls Creek, and Reynoldsville. Mill Creek, its chief tributary, joins it just above its confluence with the North Fork. The valley of Mill Creek is quite deep, at least 300 feet in some places, with rather steep slopes, but contains no tributaries of notable size. North Fork, on the other hand, has several important affluents, all of which flow through wide ravines. Sandy Lick flows through a deep, wide, rugged valley and numerous tributaries enter it along its course. There are few farms in this valley, most of the country being waste land. At its mouth it is about fifty feet wide and is stained yellow from mine drainage.

The volume of water in Red Bank Creek is extremely irregular, varying as it does from stages of high flood to periods of almost complete exhaustion. This extreme variability is largely the consequence of the condition of the surfaces of the drainage area which rapidly yield the water which they receive. The fall of the head waters is quite rapid, but during the last thirty miles it averages ten feet to the mile. A gauging of this creek on August 24th, 1908, showed the discharge to be 78.19 second feet, while the estimated minimum discharge, September 28th, 1908, was 53 second feet.

Rainfall data taken at Brookville cover a total period of twenty-two years, of which the records for twenty years are complete. The annual precipitation in inches follows: maximum, 55.48; minimum, 26.23, and the mean for total period, 40.97.

The Red Bank Creek drainage area of 526 square miles is narrow and lies between the basins of the Clarion River and Mahoning Creek. A narrow and distinct ridge divides the waters of the Clarion River and Red Bank Creek. By far the larger part of the drainage lies on the north side, the basin to the south being quite closely confined to the hills which overlook the creek, excepting the territory drained by Little Sandy Creek. Towards the north the North Fork extends far up to the Elk County line. Red Bank Creek flows for most of its length through a deep, rugged ravine, except in the region of Fairmount. Here the valley widens and the country has been brought under the plow, but by far the greater part of the country bordering Red Bank Creek is rough and rugged with steep, precipitous descents to water level. Receding from the main water course, the country becomes less rugged, though still decidedly hilly. The summits along the northern divide, between Red Bank Creek and the Clarion River, range from 500 to 625 feet above the water level in Red Bank Creek, the highest point being 1,750 feet above sea level. The descent from this divide to Red Bank Creek is much sharper than the northern slope towards the Clarion River. The bed of Red Bank Creek for most of its length is very rocky and sulphurous deposits from mine drainage are very general. At its mouth the creek is about 250 feet wide and is badly stained by mine drainage, especially from the north.

This stream has been valuable as an outlet for the lumber in Clarion, Armstrong and Jefferson Counties and many dams have been built on it for this purpose, but these dams have fallen into disuse. To facilitate the marketing of the timber in these counties, this stream was declared a public highway from Brookville to its confluence with the Allegheny River.

The total population of the basin is 61,760, divided in the following proportions: urban 29,110; rural, 32,650. The rural population is approximately fifty-seven to the square mile.

Seven municipalities, having a population of over 1,000 each, are situated in this basin. DuBois, with a population of 13,000, is the largest town on the shed.

The following list shows the water power development on Red Bank Creek and its tributaries:

Jefferson County.

Red Bank Creek,	Brookville,	2 plants.
Red Bank Creek,	Summerville,	3 plants, 1—90 H. P. 1—50 H. P.
North Branch Red Bank Creek,	Brookville,	2 plants.
Sandy Lick Creek,	Brookville,	65 H. P.
North Fork,	Richardsville,	80 H. P.
Little Sandy Creek,	Sprinkle,	16 H. P.
Little Sandy Creek,	Cool Springs,	

Red Bank Creek,New Bethlehem,
 Pine Creek,New Mayville.

150 H. P.

The most important industries of the Red Bank Creek watershed are agriculture, coal and natural gas production, and industrial plants engaged in tanning and the manufacture of glass, clay products, and pig iron. Gas is produced practically throughout the watershed. Above Brookville there are thirty-five coal mines and below Brookville forty-two mines. There are three large tanneries, the Van Tassel Tannery at DuBois, and Elk Tanning Company plants at Falls Creek and West Reynoldsville. The Adrian Furnace Company has an extensive plant just above Falls Creek producing pig iron. At Falls Creek there are two glass plants and a plant each at Brookville and New Bethlehem, and at Reynoldsville there are two woolen mills.

The territory is well served with railroads, aggregating about 130 miles.

The towns having water works systems serving the public wholly or in part are DuBois, Reynoldsville, Brookville, Summerville, New Bethlehem, and South Bethlehem, and of these DuBois and Brookville have the only municipal water works. The DuBois municipal supply is derived from Anderson Creek on the Susquehanna watershed. Wells and springs are largely used by individuals and a part of the town is supplied by private system of John E. DuBois, taking water from springs and streams in the vicinity. Reynoldsville and a small portion of West Reynoldsville are supplied by the Reynoldsville Water Company with water from Pitch Pine Run and two wells. Private wells and springs are also used. The Brookville municipal supply comes from the North Fork, one of the main tributaries of Red Bank Creek. The water is filtered. Summerville has two private companies, the Peoples Water Company and the Summerville Water Company, together serving less than one-half the population; the balance use private wells and springs. Springs and wells form the source of supply for both companies. New Bethlehem and a small portion of South Bethlehem are supplied by the Citizens Water Company of New Bethlehem, whose supply is derived from Red Bank Creek and subjected to filtration. A number of private industrial enterprises have their own supplies derived from streams, wells or springs; at Falls Creek the Elk Tanning Company derives a supply from Falls Creek, augmented by wells; at West Reynoldsville the same company uses water from a series of driven wells; at Brookville several of the plants are supplied from private springs; at Conifer the Allegheny River Mining Company derives a supply from Beaver Run for boiler purposes, consumption being estimated at 100,000 gallons a day; at Ramseytown the Shawmut Mining Company draws water for industrial purposes from a drilled well. Thus it is seen that the waters

of the stream and its main tributaries are used for domestic purposes at Brookville and New Bethlehem and but little used for industrial purposes.

On July 23rd, 1909, a sample of water taken from the centre of Red Bank Creek about fifty feet above New Bethlehem water works intake showed from five to six parts acid in a million. Another sample taken on the same day along the north bank of the creek and about one-quarter mile above New Bethlehem water works intake showed from three to four parts acid in a million. On August 14th, 1909, a test of the water of Red Bank Creek at its junction with the Allegheny River, showed five parts acid in a million. On August 13th, 1909, a test of the water of North Fork Creek at Brookville showed eighteen parts alkalinity in a million.

DuBois, Reynoldsville, Brookville and New Bethlehem have the only public sewer systems of any extent, while Reynoldsville, West Reynoldsville, Summerville, New Bethlehem and South Bethlehem all have a greater or less number of private sewers. It is estimated that 20,020 persons above and 7,670 persons below Brookville, a total of 27,690 persons, contribute, either directly or indirectly, sewage pollution to the waters of Red Bank Creek. The industrial wastes discharged into the stream are quite extensive and mention is here made of the most important of these pollutions. The Van Tassel Tannery at DuBois contributes about 400,000 gallons a day of characteristic tannery wastes containing tan liquor, lime water, and probably some sulphuric acid. The Adrian Furnace Company, just above Falls Creek, discharges wastes containing in suspension large quantities of finely divided slag which forms a troublesome deposit. The Falls Creek Tannery of the Elk Tanning Company discharges into the creek extensive wastes from hide soakings, lime water and bleach water. At Reynoldsville, the Reynoldsville Woolen Company is said to use 4,000 gallons of water a day, depositing wastes containing soap, soda, wool oil, and dye stuffs through a bed of cinders into Pitch Pine Run. Wastes from the Sykes Woolen Mills, where the water consumption is said to be 15,000 gallons a day are also discharged into this run and are probably similar in character. The Elk Tanning Company at West Reynoldsville discharges wastes from hide soakings, lime water and bleach water. Of the thirty-five coal mines inspected above Brookville, five have pump drainage, the amount of which is 5,425 gallons a minute; from the remaining thirty, 5,255 gallons of mine water a minute drain naturally and discharge into Red Bank Creek or its tributaries. Of the forty-two mines noted below Brookville, thirty-three have natural drainage, amounting to 3,160 gallons a minute, and nine depend upon pumps which deliver 2,250 gallons a minute.

DuBois, Clearfield County, population about 13,000, is situated in the northwestern part of the county near the Jefferson County line on Sandy Lick Creek, (the largest branch of Red Bank Creek), entering Red Bank Creek at Brookville. Sandy Lick Creek is practically the upper portion of Red Bank Creek. DuBois is a coal mining, railroad and manufacturing town, though originally founded on the lumber industry. Its industrial plants include repair shops of the Buffalo, Rochester and Pittsburgh Railroad Company, employing about 450 men, and car shops employing 280 hands; the DuBois Iron Works, with about 100 men, manufacturing gas engines and steam pumps; the A. R. Van Tassel Tannery with about 100 men, handling about 250 hides a day; a wood-working plant, a grist mill, machine shops, a brewery, and a distillery. The borough has a municipal water supply derived from Anderson Creek, just over the divide eight miles to the east and tributary to the Susquehanna River. From a small impounding reservoir with a population of 200 persons on its thirty square miles of watershed, the water is conducted by way of a tunnel through the mountain to a gate house on the western slope and thence to the distributing mains. About sixty per cent. of the property owners use the public supply, the remainder getting their drinking water from dug and drilled wells, springs, and the private water system of John E. DuBois. This private water system of Mr. DuBois supplies water for industrial purposes to several plants in the northern part of the borough and to the residents in that section. There is also a connection with the municipal system for the purpose of augmenting the borough supply in times of drought. The sources of supply are several small streams, tributary to Sandy Lick Creek, including Narrows Creek, Wolf Creek, Whipple Creek, Spring Run, and numerous springs. The watersheds are uninhabited and controlled by the owner of the water works, who is conducting reforestation operations thereon and carefully protects the supply. The borough has a municipal sewer system with a single twenty-four inch outlet, and in addition has secured control of a number of private sewers, making a total of fourteen miles of sewers under municipal ownership. It is estimated that 10,000 persons contribute sewage pollution. Aside from the domestic sewage pollution, the stream is contaminated at DuBois by industrial wastes from the A. R. Van Tassel Tannery. Its wastes include tan liquors, lime water from dehairing, and some sulphuric acid, and amount in all to about 400,000 gallons a day of liquid wastes. Other industries here contribute manufactural wastes probably of little importance.

In a decree relative to sewerage issued to DuBois by the Commissioner of Health in April, 1909, may be found the following discussion of the situation there:

"It is plainly evident that general extensions to the borough sewer system are needed. Grades will be ample, inspection manholes will be placed at street inter-

sections and at changes in line or grade as has been the custom with the old sewers. Ventilation is secured through perforated manhole covers. The entire system now constructed is efficient with the exception of the main trunk and intercepting sewers on the flats. These sewers were built in eighteen hundred and ninety-four, before the dam was erected on the stream below the furnace. Since the formation of the pool above the dam whose normal level is two feet above the invert of the trunk sewer outlet the water is constantly backflooded in this sewer and the interceptor for a long distance up-stream and when the overflowing of the meadows occurs this backflooding is even more extended. In January of this year, on the date of the Department's inspection, the top of the said sewer was submerged eighteen inches at the outlet.

"The coal mines in the vicinity are operated by shafts generally speaking, and the water is pumped therefrom. The coal deposit is not inexhaustible. The shutting down of the mines or the abandonment of the field will ultimately result in a reduction to a very large degree of the acidity of Sandy Lick Creek. The nuisance which now exists in the stream must increase if no change is brought about and the menace to public health by sewage pollution of the water which now exists, especially during high stages of the streams when the germicidal effects of the acids are largely dissipated through dilution, would also increase as the years go by if no changes were made in the method of sewage disposal. It is easily possible for pathogenic organisms to be transported down stream to the water works intake at New Bethlehem and be introduced into the homes of the water consumers in that borough."

Falls Creek, Jefferson County. population 2,000, is a borough situated in the extreme eastern part of Jefferson County on Sandy Lick Creek, the principal tributary of Red Bank Creek, and about three miles downstream from DuBois, Clearfield County. The industries of the borough and its immediate vicinity include plants for the manufacture of window glass, plate glass, brick works, planing mill, a large tannery of the Elk Tanning Company, extensive furnaces of the Adrian Furnace Company, and stone quarries. Practically the entire population, either directly or indirectly, contribute sewage to the stream. The Adrian Furnace Company, just above the town, has a plant for the granulation of its slag, a process resulting in the discharge of large quantities of slag in a finely divided state into the stream. At times of high water this material is washed down and deposited on the flooded lowlands below, where it is said to cause damage to the land so affected. The most serious pollution at Falls Creek is caused by the wastes from the Elk Tanning Company's tannery. This is located on Falls Creek near its junction with Sandy Lick Creek. It is a large plant having a capacity of about 400 hides a day. The daily liquid wastes from this plant include water from hide soaking, lime water, and bleach water. It is reported that in 1897 an outbreak of anthrax occurred among cattle drinking the waters of Sandy Lick Creek below Falls Creek.

In October, 1910, the Commissioner of Health issued a decree relative to water works to Falls Creek borough. In it may be found the following discussion:

"The greater portion of the watershed area tributary to the proposed storage reservoir in Falls Creek is farm land in a high degree of cultivation, while a portion of it is woodland, chiefly along portions of the creek. Under normal conditions the watershed will comprise seven square miles with a population of fifty-seven per square mile. The Kyle Run watershed which is available in emergencies comprises six square miles with a population of twenty per square mile, making an average population on the drainage area of forty per square mile. The occupied

estates on Falls Creek are for the most part scattered with the exception of a small group of houses called Rockdale Mills, which is near the creek and about two and one half-miles above the dam site. A number of the farm dwellings are in close proximity to the stream or its tributaries. In view of the extensive settlement of the territory it would not be surprising to find a considerable pollution of the creek water. Analysis of samples taken by the Department on August fifteenth, one thousand nine hundred and ten, show this to be the case. The results of these analyses were as follows:

	Bacteria per c. c.	B. Coli per c. c.
1. Falls Creek, 1,100 ft. above intake pipe,	300	0
2. Falls Creek near Rockdale Village,	100	20
3. Kyle Run above intersection with Falls Creek,	1,500	33
4. Tap in Falls Creek Borough,	100	3
5. Tap in Falls Creek Borough,	300	4

"In one thousand nine hundred and two one case of typhoid fever occurred on the Falls Creek watershed and in one thousand nine hundred and three, four cases. In one thousand nine hundred and eight there was a case of typhoid fever on the Kyle Run watershed. In one thousand nine hundred and nine, as already noted, typhoid fever existed just above the intake of the water works and to avoid contamination of the supply from this source, a new intake was constructed at a point further up-stream.

"A single case of typhoid fever on the watershed of a public water supply may readily result in dangerous illness to a large portion of the community using this water and be the cause of many deaths. This fact was learned at terrible cost at Plymouth, Butler, Nanticoke, and other places where well known epidemics have occurred. At Nanticoke a portion of the community receiving the public supply was free from the disease. Investigation showed that the water delivered to this district had the benefit of sedimentation in a reservoir which proved a sufficient barrier to prevent the transmission of the disease. A number of the cases of typhoid fever which have occurred in Falls Creek borough in the past few years were in portions of the town not supplied with public water and were attributed to the use of polluted wells and springs. There are also a number of cases which may have been due to the infection of the public water. The utmost vigilance is necessary to reduce the danger of such infection.

"It is not apparent to the Department from what source the municipality is to obtain the money necessary to defray the cost of the dam and its appurtenances and the new pumping station machinery and additional water pipe lines. If the facts have been correctly reported to the Department, it is conclusive that the municipality does not have funds to do all of this work and to erect a water filter plant. Nevertheless, it has been hereinbefore shown that the water is not safe to drink in its raw state. There should be a treatment plant erected. While the impounding reservoir proposed would, under normal conditions, afford somewhat of a barrier to the transmission of water-borne diseases, at the same time it would not be a barrier sufficient to garrison the town against an invasion of an epidemic. The Department would not permit a private corporation to obtain the proposed source from Falls Creek except in connection with a water filter plant, and, therefore, the Department should not discriminate in favor of a municipal corporation since the public would suffer equally in the event of an outbreak of water-borne disease. The risk to public health proposed by the municipality is hazardous and one which the Commonwealth is not willing to bear with the local authorities. It is possible that the town can enter into contract with some filter company whereby the latter will contract to erect a water filter plant and receive payment therefor by yearly installments on a basis that will bring the cost of this plant within the financial ability of the town to assume.

Reynoldsville, Jefferson County, population 4,000, is situated on the east bank of Sandy Lick Creek in the eastern part of the county and on the opposite side of the creek from West Reynoldsville borough. While the surrounding territory is largely agricultural, there are bituminous coal deposits which are extensively worked. The industries in the borough and its immediate vicinity, not including West Reynoldsville, comprise the Reynoldsville Woolen Mills, with about forty employees, the Sykes Woolen Mills, with about thirty-five em-

ployees, a small structural steel and iron works, the Reynoldsville Distillery, and two brick works. Water is supplied to the public by the Reynoldsville Water Company from a surface supply on Pitch Pine Run and one of its tributaries, augmented occasionally by pumping from two drilled wells. On the watershed of the two surface supplies there are occupied estates. Two public drinking fountains are supplied from a spring which appears extremely liable to pollution. The public water is in quite general use. There are five public sewer outlets in the borough, three of them being into Sandy Lick Creek and one each into Soldier Run and Pitch Pine Run, the system aggregating 3.7 miles in length, ranging in size from four to eighteen inches and receiving both sewage and storm water. There are also a number of private sewers from individual properties entering the creek and the runs. Pitch Pine Run, forming the source of water supply, consists, in dry weather, of practically nothing but the sewage of the borough, while Soldier Run receives the drainage from a number of coal mines as well as borough sewage, both streams forming in consequence nuisances and menaces to the health of the inhabitants. There are many drains for kitchen wastes discharging to the highways and to the streams, and numerous privies overhanging the runs contribute direct pollution. On May 8th, 1908, the Commissioner of Health issued a permit for the temporary discharge of sewage from a certain proposed sewer and requiring that plans for a comprehensive sewerage system and sewage disposal works for the treatment of the borough sewage be prepared and submitted to the Commissioner of Health for approval. The Commissioner of Health also urged the policy of co-operation in the matter of sewage disposal with the borough of West Reynoldsville on the opposite side of the creek. Industrial wastes are contributed by the Reynoldsville Woolen Mills, the Sykes Woolen Mills, and the distillery. The wastes from the Reynoldsville Woolen Mills, where 4,000 gallons of water are used daily, contain soap, sal-soda, wool oil and dye stuffs and are allowed to percolate through cinders before entering Pitch Pine Run. At the Sykes Woolen Mills the daily consumption of water is said to be 15,000 gallons. The wastes from this plant also enter Pitch Pine Run. The wastes from the distillery are probably of comparatively small importance.

The sewerage decree of May, 1908, contained the following statements by the Commissioner of Health relevant to sewerage:

"From the several mining operations on Soldier Run watershed is discharged daily a considerable volume of sulphur water and the characteristics are evidenced all along the stream to its mouth. The petitioners represent that this acid germicide will neutralize sewage poisons which may be discharged into the water from the proposed sewer. Sandy Lick Creek above Reynoldsville also receives mine drainage even above DuBois.

"Sandy Lick Creek rises in Clearfield County east of DuBois in the Allegheny Mountains at the summit of the divide between the great Susquehanna and Ohio River basins and takes a generally westerly course for twenty-seven miles to the confluence with the North Fork at the borough of Brookville, Jefferson County, whence the stream continues southwesterly under the name of Red Bank Creek,

forming the boundary line between Clarion County to the north and Armstrong County to the south, to the Allegheny River, which it enters a short distance below East Brady borough. In its course below Brookville, a distance of forty five miles, which is also traversed by the Pennsylvania Railroad (low grade branch), there are five small boroughs, the largest of which has a population of about twelve hundred. Brookville is twelve miles below Reynoldsville. It is the county seat and has a population of under three thousand. So far as the Department is aware, the stream from DuBois to the Allegheny River is not used for public water supply purposes. The adjacent country is mostly wild and the banks high and precipitous, becoming more so as the river is approached, until within the last stretches the valley is a deep narrow gorge. The harm which sewage might do in this stream would be secondary in extent to that which it might do after reaching the Allegheny River, the waters of which are very extensively used for potable purposes. It is in the interests of public health that Red Bank Creek and its tributaries should be preserved from pollution by sewage since sewage discharged anywhere on its watershed might be transmitted in a day's time to the public water works of the municipalities along the Allegheny River below.

"Falls Creek borough is on the Sandy Lick Creek at the mouth of Falls Creek in Jefferson County at the Clearfield County line. It is a borough of about one thousand population. Here there is a large tannery owned by the Elk Tanning Company from which the wastes are discharged into Falls Creek branch and the pollution is markedly evident in summertime.

"At DuBois borough, two and a half miles above and northeast of Falls Creek borough, on Sandy Lick Creek, where reside ten thousand people, there is a large tannery known as Van Tassel's, from which trade waste is discharged into the creek. The sewers of the town also empty into the stream.

"Just above Reynoldsville, in West Reynoldsville, there is a large tannery owned by the Elk Tanning Company whose trade wastes are discharged into Sandy Lick Creek. There has been complaint in Reynoldsville about the stench during low water stages, owing to the sewage from the above mentioned places. The watershed is about one hundred and ten square miles in extent at this point. The farmers along the stream below Falls Creek and above Reynoldsville have occasionally complained about the pollutions and the injury to cattle pastured along the banks which wade in the waters and drink thereof. In the fall of eighteen hundred and ninety-seven, anthrax became epidemic among cattle belonging to farmers whose properties are along Sandy Lick Creek in this territory.

"It appears that during high water the sewage waters overflow the banks and cause deposits over the meadows to the damage of hay crops and injury to cattle pastured in the field or that eat hay gathered from the meadow. It was contended by physicians and experts that the cattle which died from anthrax poison had drunk the creek water polluted by the wastes from the tannery. The sewage from Reynoldsville may not be a greater menace to public health than the tannery wastes. Undoubtedly both should cease to be discharged into the waters of the State. Under the law of nineteen hundred and five, it is the duty of the Commissioner of Health to stop stream pollution. It is reported that the assessed valuation of Reynoldsville is about one million dollars and that its borrowing capacity to the constitutional limit of indebtedness, taking into account the present debt, is in the neighborhood of fifty thousand dollars, a sum insufficient to establish a sewage purification works for the treatment of the mingled sewage and storm water. The present sewer system seems to have been built with the idea of discharging the sewage and storm water at the most convenient points into the streams. Owing to their small sizes, the sewers are inadequate to carry off all of the storm water of intense downpours, nevertheless, their total discharge at such times would require the building of a large purification plant whose cost would be prohibitive. When the time shall have arrived for the actual construction of disposal works, only house drainage and a very limited amount of roof water should be delivered to the plant. Meantime, whatever sewers may be built should be a part of a comprehensive plan. The State authorities could not justly approve of desultory sewer extensions which ultimately would be abandoned. The borough should at once employ competent engineering service to devise a sanitary sewer system for the entire territory within its limits, using as much of the existing system as may be practicable. After such a plan is approved by the State authorities, the borough can then build sewers from time to time as called for in any street or streets, conforming to this general plan, and in this way secure the greatest economy and efficiency. The perfected plan should aim to collect and intercept all existing sewers both public and private, including the industrial wastes. Wool scourings are a particularly difficult kind of waste to treat. This can be done better in a public plant than in a plant installed therefor at the mill. It is the policy of some municipalities to foster its industries and one way is to afford a sewer outlet. Of course, such suspended matters as might be in the sewage whose admittance to the sewer would endanger it or interfere with its functions would be removed on the premises before the liquids were discharged into the sewer.

"It is certain that all improper disposal of sewage in the borough and adjacent thereto must cease and that plans to obviate pollution must be adopted.

"West Reynoldsville has applied for permission to install a system of sewers. It will be much cheaper for this borough and Reynoldsville to adopt a joint intercepting sewer and sewage disposal plant than for each to act independently."

West Reynoldsville, Jefferson County, population about 1,000, is a borough situated on the west side of Sandy Lick Creek directly opposite the borough of Reynoldsville. The Reynoldsville Tannery of the Elk Tanning Company is located here and is the chief means of support of the inhabitants and the only industrial plant in the borough. The American Silk Company has works employing about 300 persons located in the township below the borough. There are a number of domestic wells and springs scattered about the borough from which water is drawn for domestic uses, while the Reynoldsville Water Company supplies the tannery with water for all except industrial purposes. For tanning purposes water is drawn from a series of driven wells on the company's property. There is only one public sewer, an eighteen inch storm sewer, which, however, has several sanitary connections. There are about fifteen cesspools in the borough used exclusively for excreta and privies are in general use. The universal disposition of waste water from houses into the street gutters and into the small runs and alleys leading to the runs produces an offensive condition in the summer. The soil in the borough is of a clayey nature not favorable for percolating cesspools and shallow earth privy vaults and they are not unfrequently found full to overflowing. The slopes and numerous springs are so located that surface pollution of the springs and wells is liable to happen at any time. The borough authorities have under consideration plans for a comprehensive sewerage system and the Commissioner of Health issued a decree on May 7th, 1908, urging upon the borough the advisability of co-operating with the borough of Reynoldsville in the matter of future sewage disposal. The wastes discharged from the "Reynoldsville" tannery of the Elk Tanning Company are very extensive, from hide soaking, lime water, and bleach water.

In the sewerage decree issued by the Commissioner of Health to West Reynoldsville in May, 1908, the following statements may be found:

"It is evident by the plan that the borough council desires that the State Department of Health initiate the sewer design. It appears from the information now at hand that no difficulty will be encountered in obtaining grades for the sewers equivalent to a fall of six inches in one hundred feet or greater, with the exception, possibly, of the main sewer across the meadows. As laid out, the sewers will follow closely the natural topography, thus requiring the least cut to obtain intersecting grades for the system. The sizes of the sewers need not be greater than necessary to remove sewage proper. Six inch pipes on four per cent. grades, or greater, should be ample for laterals. The size of the outlet might be governed somewhat by the volume of sewage discharged from the tannery. Such a volume will be much larger than the total output of sewage from all the other buildings in the borough. Storm water and drainage from the run should be excluded from the sewer. A moderate amount of roof water at sewer ends might be admitted for flushing. Surface drainage can be improved most economically in West Reynoldsville independent of the problem of removal of sewage from the community.

"No disease is more dangerous than anthrax and no infectious disease harder to eradicate after it has once gained a foothold in a community. This poison should be killed at the outset and the discharge into any stream of tannery drainage is a menace provided the waters are subsequently used by man or beast. In the fall of eighteen hundred and ninety-seven, an epidemic of anthrax broke out among the cattle owned by the farmers whose lands abut Sandy Lick Creek

between West Reynoldsville and Falls Creek. State and local authorities, after thorough investigations, arrived at the conclusion that the disease was attributable to the infection from the tanneries. The meadow lands along the stream are subject to overflow and the grasses are thus washed by sewage water. The belief would seem to have some foundation in fact that cattle pastured along the stream, or that feed upon the hay cut from the overflowed meadows, are liable to be poisoned.

"Not only the tannery wastes but the sewage from DuBois and Falls Creek and the Reynoldsvilles may be transmitted down-stream to the Allegheny River and to the water works intakes of the numerous municipalities along this river's banks and thus be introduced into homes of water consumers in a sufficiently active pathogenic condition to cause sickness and death. The extent of the menace in Red Bank Creek valley is secondary to the menace to public health in the Allegheny valley. The interests of the public health demand that these upland waters should be preserved in their purity. The question of their use is not one of a local nuisance as often popularly and selfishly thought to be the case. West Reynoldsville cannot expect a permanent right to discharge its sewage into Sandy Lick Creek and in anticipation of the ultimate purification of the sewage, the borough should plan its sewer system accordingly. It is not practicable to purify surface drainage and sewage combined and hence the necessity for the exclusion of surface waters from the sewers. The local authorities should engage the services of some qualified expert to work in conjunction with the local engineer in initiating a comprehensive sanitary sewer design for the collection of all the sewage in the borough and its conveyance to some suitable point within or without the borough for treatment. The site should be selected and outlined plans made for the sewage works and these should be submitted to the Commissioner of Health for approval. It may then appear that the interests of public health will be subserved by granting temporary permission to the borough to discharge the sewage into the creek.

"The council of Reynoldsville has made an application for permission to extend its sewer system and to discharge the sewage therefrom into the waters of the State. It would be both economical and best that the two municipalities should adopt a joint intercepting sewer and sewage disposal plant. This should prove much cheaper than if each borough were to proceed independently. The mingling of the domestic sewage of both towns with the industrial wastes from the tannery and from the woolen mills would facilitate the purification. The American Silk Company have works employing about three hundred people which are located below the borough in the township, from which sewage is discharged into the creek about a quarter of a mile below the Reynoldsville borough sewer. There is a community of interest irrespective of municipal boundaries and including the public and private corporations which can best be represented by a co-operative sewerage and sewage disposal plant. The project should be worked out and submitted to the Commissioner of Health for approval and then the sewers built in West Reynoldsville from time to time as needed should conform to the adopted plan and be a part of the project, which, when completed, will have brought about the non-pollution of the stream in the territory by easy and practicable stages in an economical and efficient manner."

Brookville, Jefferson County, population 3,100, is a borough and the county-seat and is situated at the confluence of the North Fork and Sandy Lick Creek, which here unite to form Red Bank Creek. The topography is irregular and the borough is built upon steep slopes forming the banks of the streams. The surrounding territory is rich in coal and gas, and agricultural pursuits are largely practised. The local industries include the Brookville Glass and Tile Company, manufacturing window-glass and employing 150 persons, and the A. D. Deemer Furnace Company, employing seventy-five, the Brookville Manufacturing Company, employing about twenty-five persons, in the manufacture of wagons, beside a foundry and machine shop, two breweries, two planing mills, each employing from five to twenty persons, and a woolen mill. There are two small water-power developments here on Red Bank Creek. Within the borough is located the Pennsylvania Memorial Home, maintained by the Woman's Relief Corps of Pennsylvania and having about forty inmates. Formerly the Brookville Water Company supplied the borough with water. The supply was taken from the

North Fork at a dam within the borough limits. The reservoir so formed was formerly used for lumbering purposes in connection with a saw mill and contained decayed timber, receiving as well a small amount of drainage from the borough. The watershed for the most part is covered with thick second growth timber and thinly settled farm land with a small village with a population of perhaps seventy-five persons, and just above Brookville a group of cottages with a summer population probably not exceeding fifty. The system includes three storage tanks of 3,000 barrels' capacity each and over nine miles of distributing pipes serving some 600 taps, the consumption being about 700,000 gallons daily, all for domestic purposes. The local Board of Health made unsuccessful attempts to secure filtration or equivalent improvement in the character of the water supply and the State Department of Health had to take the matter under consideration. The industrial plants in several cases derive private supplies from springs. The principal part of the borough has a combined sewerage system. There are also many private sewers and a large number of privies. Probably the entire population directly or indirectly contributes sewage pollution to the stream.

In February of 1910 a typhoid fever epidemic broke out in Brookville and the State Department of Health went there and conducted an investigation and introduced a germicide into the water supplied by the water company to the town for drinking purposes. In May of that year the Brookville Water Company was notified that it must proceed to prepare plans for the installation of a water purification plant. In August of 1910 the Commissioner of Health issued a permit approving plans for the construction of a new concrete dam on the North Fork Creek and a mechanical filtration plant, pumping station, and a force main to the town, but in this permit the plans for the dam were returned by the Commissioner of Health for changes. The space provided for a spillway to let the freshet waters from the mountainous drainage areas above pass without injury to the dam was insufficient. The changes were made in the plans, but the company went on and built the structure without conforming to these changes. It then sold the works to the town of Brookville. Subsequently a Department engineer discovered the facts and the Commissioner of Health notified the borough of the insecurity of the dam. The town authorities ridiculed the idea and engaged in some abuse of the Department. The matter was placed in the hands of the Attorney General and the residents in the valley below were warned by the Department. Shortly after, on July 17, 1912, a cloudburst occurred in the mountains and the torrents came down, flooded the spillway as predicted and then backed up and flowed over the earth embankment, washing it out and nearly undermining the foun-

dations of the dam. Considerable damage was caused and the borough was put to an unnecessary outlay of money. Fortunately no lives were sacrificed.

Corsica, Jefferson County, is a small interior borough with a population of about 400, close to the western boundary of the county, and drained by a small run tributary to Red Bank Creek just about four miles distant. It is surrounded by good farm country and underlain by coal which is extensively mined in the vicinity. There is no public water system, the inhabitants deriving their supply from many private dug wells, three springs and three drilled wells. Kitchen waste is generally discharged to the ground, and the box privies are almost universally used and for the greater part well cared for. In a few instances kitchen drainage and domestic sewage reach the small run.

Summerville, Jefferson County, population 800, is a borough situated on Red Bank Creek near the western boundary of Jefferson County. It is in an active coal and gas producing field, having two coal mines near by. The only industries within the borough are a saw mill and a grist mill. There are three water power developments on Red Bank Creek here, two of them developing respectively 90 H. P. and 50 H. P. Over one-half of the public obtain water for domestic purposes from wells and springs, the others deriving their supply from two small water companies, the Peoples Water Company, furnishing possibly 200 persons with water from springs augmented by a drilled well, and the Summerville Water Company, furnishing water from springs to about eight families. There is one public sewer in the borough and about fifteen private sewers from individual properties, one of them serving four families, beside a large number of small drains discharging kitchen waste into the creek. Privies are in general use, in a number of instances on the banks of the runs or the bank of the creek.

Worthville, Jefferson County, is a borough with a population of 150, situated on Little Sandy Creek, a tributary entering Red Bank Creek near the western boundary of Jefferson County. It is surrounded by a rich farming country containing considerable coal and natural gas, although these latter resources are undeveloped in the vicinity. Water for domestic use is derived principally from wells, extending to water-bearing gravel. Privies are in general use, there being no sewers. In the southwestern portion of the borough a number of privies overhang or drain to an abandoned millrace and an adjoining swamp.

Hawthorne, Clarion County, (formerly West Millville), is a borough with a population of 800 on Red Bank Creek in the southeastern corner of the county. The surrounding region is productive of natural gas and there are three large coal operations near by. Within

the borough there is but one industry of importance, the Hawthorne Pottery Company, employing thirty-five persons in the manufacture of stoneware. The inhabitants derive water from private dug wells and a few drilled and driven wells and springs. There are no public sewers and surface privies are universally used. Some of these privies and a number of pigpens contribute pollution to the highways or the creek.

New Bethlehem, Clarion County, population about 2,000, is a borough situated on Red Bank Creek about twenty-one miles from its mouth. Its industries include the New Bethlehem Window Glass Company, employing about 125 persons, the New Bethlehem Planing Mill Company, with thirty employees, the C. E. Andrews Sons planing mill with about forty employees, the New Bethlehem Brewing Company, brick works, tile and hollow brick works, and a grist mill, with a water power installation on Red Bank Creek developing 150 H. P. Water is supplied to the public by the Citizens Water Company of New Bethlehem, whose supply is pumped from Red Bank Creek and subjected to mechanical filtration before reaching the consumers, of whom there are about 1,400. The daily consumption is 80,000 gallons, of which about one-half is used for industrial purposes. The remaining population depends upon drilled and dug wells. The borough has a combined system of public sewers with an outlet into the creek at the down-stream end of the town below the mill dam, and above the dam there are twelve private drains discharging into the creek or Leisure Run, a small tributary. Privies are in use and about a dozen cesspools. There is no serious pollution from industrial wastes in the borough.

South Bethlehem, Armstrong County, population estimated at 460, is a borough situated on Red Bank Creek opposite and just below New Bethlehem, Clarion County. It is the last settlement on Red Bank Creek which below this point follows a sinuous course between high banks which become more precipitous and form a narrow gorge as the Allegheny River is approached. The borough is largely residential, forming practically a suburb of New Bethlehem, and its inhabitants are principally interested in the coal operations of the Fairmount Coal Company near by. There are only three industries in the borough, a grist mill, an electric lighting plant, and a woolen mill, but the last named plant has not been in operation recently. Water for public use is derived principally from wells but possibly 100 persons are supplied by the Citizens Water Company of New Bethlehem with filtered water derived from Red Bank Creek. While there is no public sewer system in the borough, there are several private sewers, all of which discharge into the tail-race from the mills. There are three of these sewers serving in all eleven properties. The rest of the sewage of the borough is disposed of either

to the surface of the ground or into cesspools, privies or dug wells. There are eighty privies in the borough, constructed for the most part over vaults dug to a depth of twenty feet where a gravel stratum is reached. This gravel, however, appears to be easily clogged and great trouble is experienced from the filling up and overflow of these wells. Slop and wash water is largely disposed of through terra cotta drains from the houses into the gutters along the streets, finally reaching the creek. The borough officials have under consideration the construction of a system of sewerage for the entire municipal territory.

A decree relative to sewerage was issued by the Commissioner of Health to South Bethlehem in March, 1909. It contained the following discussion:

"In making application for a permit to discharge sewage into the waters of the State untreated, the borough officials have dwelt strongly on the fact that this territory is sparsely populated and that there are no communities below South Bethlehem borough which take their water supply from this source until the borough of Kittanning is reached. This borough is forty-four miles below South Bethlehem on the Allegheny River. The borough authorities further state that above New Bethlehem there are seventeen producing coal mines and twenty-eight abandoned coal mines discharging sulphur water into Red Bank Creek and that the existence of these acids in the water will completely sterilize the sewage before it reaches the intake of any water supply.

"The existence of acids from mine water in Red Bank Creek may be sufficiently strong during low stages of flow or even during normal stages of flow to sterilize the pathogenic bacteria discharged by sewerage systems, but there are many periods during the year when the flow is sufficiently great to so dilute the amount of mine drainage that the effect of these acids would be negligible. Furthermore, the extent of the menace in Red Bank Creek is secondary to the menace to public health in the Allegheny Valley. The interests of the public health demand that these upland waters should be preserved in their purity. The question of their use is not one of local nuisance as often popularly and selfishly thought to be the case. South Bethlehem borough cannot expect a permanent right to discharge its sewage into Red Bank Creek and in anticipation of the purification of the sewage, the borough should plan for an intercepting sewer and a disposal works location.

"The boroughs of Reynoldsville and West Reynoldsville have made application to the State Department of Health for the approval of sewerage systems and a permit to discharge sewage into the head waters of Red Bank Creek was only issued under the condition that the boroughs should prepare a comprehensive plan for a sanitary sewerage system and sewage disposal works for the collection of the sewage and its treatment and that these plans should be submitted to the Commissioner of Health for approval on or before May first, one thousand nine hundred and nine. Furthermore, it was stated that the permit should cease on the first day of May, one thousand nine hundred and eleven, but that the Commissioner of Health might extend the time in which sewage should continue to discharge into the waters of the State after that date, provided the conditions of the permit were complied with. These municipalities are located as far above South Bethlehem as that borough is above Kittanning and while the water works of the borough of South Bethlehem is supplied with a filtration plant, yet there is always a great danger of pollution when the source of supply is open to contamination.

"Undoubtedly the existing unsanitary conditions in South Bethlehem should be remedied. The fact that many of the wells used for water supply are open to contamination should furnish a strong incentive for the borough to immediately install a sewerage system which will allow a more abundant use of water and consequently the introduction of the city water supply into more general use. While several of the houses in the borough are at present equipped with house sewers discharging into the canal, yet these people who are operating private sewers polluting the waters of the State, are violating the law and are open to a notice of abatement of the pollution. It is, therefore, extremely important for them to obtain a sewerage system approved by the State as otherwise they will be compelled to independently install some effective means for removing the pollution.

"The plans for the sewers should be modified so as to eliminate all storm and roof water from the system and to carry all sewage to one common point for disposal. The plans provide for taking care of the storm water at several points in the eastern district which will increase the flow of sewage many times during the

wet season and necessarily make the cost of disposal excessive. In eliminating the storm water from the sewers the sizes can be made materially smaller which will reduce the cost of installation. An eight inch sewer will be sufficiently large for the main sewers in the two districts and a ten inch interceptor will more than take care of the maximum flow of sewage.

"The borough officials in their application have stated that the construction of an intercepting sewer will be expensive on account of the depth of cut at the ridge and the difficulty in obtaining a right of way along the canal near the foot of the ridge. On account of the pollution existing at the mills and the necessity for its abatement, the owners should be willing to co-operate with the borough in the installation of a sewerage system and there should be no trouble in obtaining a right of way through this territory as it will allow the mills facilities for discharging their sewage into the system. An intercepting sewer can be constructed under the present plans with very few modifications. The sewer can extend from a point near the foot of the main outfall sewer in the eastern district along the south bank of the canal to the outfall in the western district. The territory in the eastern district is sufficiently high to allow enough drop for the construction of this sewer. Temporarily, however, the eastern district can be discharged through the existing storm drain into Red Bank Creek as originally planned so that it will not be necessary to construct the outfall sewer until the disposal plant is constructed.

"The State authorities do not have information as to the availability of a site for a disposal works below the borough to which the sewage could be conducted by gravity. On account of the rapid flow in the creek and the steepness of the slope at points in front of and above the borough it is not improbable that an available site could be secured where the plant could also be operated by gravity. It will be necessary for the borough officials to make an investigation of this matter, however, before the location and the type of plant can be selected. In preparing plans for the disposal, it would be advisable for the borough authorities to unite with the authorities of New Bethlehem borough in taking care of the sewage at a common plant. New Bethlehem borough, as previously stated, at present discharges its sewage into Red Bank Creek at a point a few hundred feet below the water works intake and as this plant is located near the eastern boundary of South Bethlehem borough it is probable that the sewage could be carried across the creek at this point and conducted by gravity through the proposed intercepting sewer for South Bethlehem borough. In case this is decided upon in the plans, it will be necessary for South Bethlehem to construct an interceptor large enough for the combined sewage of the two boroughs. While the other settlements located adjacent to South Bethlehem borough at present have no sewerage systems, yet provision could be made for the ultimate installation and drainage of sewage from these sections into the same system. A plan of co-operation is advisable not only in maintaining a higher efficiency in the operation of the plant, but also in materially reducing the initial cost of construction and the annual charges for operation and maintenance."

(c) *Typhoid Fever.* In Table XL are given the typhoid fever cases reported to the State Department of Health by the local authorities for the district for the years 1906 to 1912, inclusive:

TABLE XL.

Typhoid Fever Cases Reported for the Section of the Allegheny Basin from Red Bank Creek to Mahoning Creek, 1906—1912, inclusive.

Town.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
New Bethlehem,	0	0	3	2	10	10	3
West Bethlehem,	0	0	2	0	0	0	0
DuBois,	0	25	32	19	1	35	19
Brookville,	10	15	16	5	58	11	7
Reynoldsville,	2	1	1	2	1	0	0
West Reynoldsville,	0	0	0	0	0	2	0
Summersville,	1	2	0	0	2	0	0
Worthville,	0	1	0	0	0	0	0
Falls Creek,	0	10	0	5	8	0	0
Corsica,	0	0	0	0	0	0	1

Section 13.—Mahoning Creek to Crooked Creek.

(a) *Along Allegheny River.* From Mahoning Creek the river flows in a general southerly direction through the central part of Armstrong County for a distance of about eleven miles to Kittanning. The hills on both sides of the river recede from the banks of the stream and bottom lands again make their appearance. On the west side of the river the land is chiefly devoted to farming while on the east are many coal mines. The total population for this part of the Allegheny River basin is 11,160 divided as follows: urban 3700, rural 7460. Yatesboro, the largest town in this portion of the watershed, has 2800 inhabitants. From Kittanning the Allegheny river flows in a southerly direction for a distance of five miles where it is joined by Crooked Creek. On the east bank the sloping hills are cultivated while on the west most of the farms are on the up-lands. Dredging operations to improve the channel for navigation are in progress below Kittanning. The total population of this section is 13,810 divided as follows: urban 11,280, rural 2530. Ford City, population 4000, Kittanning, population 4000, and Wickboro, population 2000, are the largest towns. In this section above Kittanning coal mining is the dominant industry although considerable attention is being paid to agricultural pursuits.

The Allegheny Division of the Pennsylvania Railroad follows the east bank of the river throughout this division and a branch of the Buffalo, Rochester and Pittsburgh traverses it from east to west a total distance of about thirty-two miles of railroad. Yatesboro and Rural Valley have public water supplies drawn from driven wells.

A regular gauging station was established at Kittanning in 1904 by the United States Geological Survey and later has been maintained by the Pennsylvania Water Supply Commission. During the period from August, 1904, to December, 1908, the mean discharge was 16,801 cubic feet a second, the maximum 175,500, the minimum 844 equivalent to a discharge of 0.10 in second feet to the square mile from the tributary area above (8,744 square miles).

It is estimated that there is a sewage polluting population on this portion of the watershed above Kittanning of 2,170 persons. Aside from this domestic sewage, the principal pollution comes from the coal mines. There are nineteen mines, fifteen of which have natural drainage, amounting to 1,025 gallons a minute, while four have pumps delivering a total of 1,850 gallons a minute.

Rural Valley, Armstrong County, is a borough with a population of 900, lying about thirteen miles east from the river and Kittanning near the head waters of Cowanshannock Creek. The ground has a gradual slope from the built-up portion toward the creek, about one-quarter of a mile distant, giving good natural drainage. Originally a farming community, the town is now industrially dependent mainly upon extensive coal operations in the vicinity. The water supply is owned by the borough consisting of a drilled well over 300 feet deep, located in the valley, from which water is pumped to a tank, and thence distributed by gravity to the consumers through a six-inch and four-inch main. The consumption is 60,000 gallons a day. Only three or four houses have a closet and bath. The borough has no sewer system, cesspools receiving the closet and bath wastes and privies being in general use. Kitchen wastes, some barns and pig pens and in many cases privies, drain into the streets and alleys and small runs, resulting in an unsanitary condition. The borough contemplates the construction of sewerage facilities for a portion of the town.

Yatesboro, Armstrong County, is an unincorporated village in Cowanshannock township about twelve miles east of Kittanning and a mile west of Rural Valley on Cowanshannock Creek. The population of about 2,800 persons is entirely dependent upon the coal operations of the Cowanshannock Coal and Coke Company which owns practically all of the houses. Water is obtained from three drilled wells from which it is pumped to tanks and distributed throughout the town. Fifty house taps and a hundred hydrants supply water for domestic uses. A few residences of officials have closets and bath. The few private sewers in the town come mainly from these houses. Otherwise there are no sewers and the inhabitants generally use privies. Kitchen wastes are usually discharged on the ground. For boiler purposes the coal company derives a supply from a reservoir on Cowanshannock Creek and six drilled wells.

In the section including Kittanning and below it, the industries are clay products, glass, iron and steel manufacturing plants being located at Kittanning, Manorville and Ford City. There are eleven small coal mines, ten having natural drainage and delivering 211 gallons a minute and one pumped mine delivering 80 gallons a minute.

The Allegheny division of the Pennsylvania Railroad follows the east bank of the river, being the only railroad here.

Appelwold, Wickboro, and Kittanning are supplied with water by private corporations, West Kittanning and Manorville by private wells and springs, and Ford City has a municipal plant system pumping water from a "filter" crib in the river with an emergency supply of raw river water. Private industrial supplies are derived from the river by the Kittanning Plate Glass Company at Wick

boro, the Kittanning Iron and Steel Company at Kittanning, and the Pittsburgh Plate Glass Company at Ford City.

Domestic sewage of a population estimated at 11,360 is discharged into the river in this division. While the various industries discharge manufactural wastes of considerable volume, they appear not to be of a seriously polluting nature, and probably have little effect on the chemical and bacteriological character of the water. Exception should be made of the coal mines mentioned above.

In this table are given a sanitary chemical analysis of the Allegheny River water at Kittanning, made by the State Department of Health, and the mineral analyses of the river.

TABLE XLI.

Sanitary Chemical Analysis of Allegheny River at Kittanning.
Parts per Million.

Determination.	Feb. 8, 1907.
Free Ammonia,	0.122
Albuminoid Ammonia,	0.045
Nitrites,	None.
Nitrates,	2.50
Chlorine,	9.0
Required Oxygen,	1.3
Total Solids,	112.0
Loss on Ignition,	10.0

Mineral Analyses of Allegheny River at Kittanning.

Determination.	May, 1906.	May, 1906.
Volatile and Organic,	7.7	6.0
Silica,	5.1	2.6
Iron and Aluminium Oxide, .....	.8	.8
Calcium Oxide,	19.2	19.2
Magnesium Oxide,	5.3	7.1
Sodium Oxide,	9.1	6.3
Sulphuric Anhydride,	12.3	13.0
Carbonic Anhydride (Fixed),	13.2	13.2
Carbonic Anhydride (Free),	9.8	1.0
Chlorine,	12.0	12.0
Nitric Anhydride,	Trace.	Trace.
Calcium Carbonate,	19.0	18.0
Calcium Sulphate,	20.9	22.1
Magnesium Carbonate,	9.1	9.7
Magnesium Chloride,	2.2	6.3
Sodium Chloride,	16.9	11.8
Alkalinity,	29.9	29.9
Total Solids,	81.7	77.3
Suspended matter,	16.2	9.4
Free Carbonic Acid,	2.8	1.0
Incrusting Solids,	64.8	65.5
Non-Incrusting Solids,	16.9	11.8

Applewold (or Applewood), Armstrong County, is a borough with a population of 280, located on the west side of the Allegheny River opposite Kittanning. It is residential in character having no industries. Water is supplied by gravity from two springs, by the

Franklin Water Company to virtually the entire population. Water is distributed from five tanks with a combined capacity of 11,000 gallons. The borough has excellent sewerage facilities, having a separate sanitary system and storm sewers each with two outlets to the river. In addition to these, there are some thirteen private sewers discharging from individual properties into the river.

West Kittanning, Armstrong County, is a residential borough, population 400, situated on the bluff opposite Kittanning and immediately west of and above Applewold. There is no public water system, the supply being mainly from individual driven wells. Kitchen waste is generally deposited on the ground and in some cases reaches the street gutters. The inhabitants find employment in the mills of Kittanning across the river.

Wickboro Borough, Armstrong County, population 2,000, lies on the east bank of the river adjoining the northern portion of Kittanning, both being practically one community. Its industries comprise the plant of the Wickboro Mirror factory, the Pennsylvania China Company, the Kittanning Plate Glass Company, and the Kittanning Brick and Fire Clay Company. The Kittanning Plate Glass Company has 350 employees engaged in the manufacture of plate glass. The Pennsylvania China Company employs 225 persons, the Kittanning Brick and Fire Clay Company employ about 150 persons and the Wickboro Mirror Works has about 18 employees. The Armstrong Water Company, a private corporation, supplies the public with water for domestic purposes. The supply is derived partly from springs and partly from the Allegheny River, the latter water being subjected to filtration. The raw water intake and pumping station formerly used are now retained for emergency purposes. The borough has a combined sewer system comprising about three miles of sewers with two twenty-four-inch outlets into the river, in addition to which there are about 1,700 feet of sewers connected to and discharging into the Kittanning borough sewers. On May 4th, 1908, the Commissioner of Health issued a permit for certain sewer extensions, allowing the discharge of sewage into the waters of the State. The large industrial plants discharge more or less of manufacturing wastes into the river. The Kittanning Plate Glass Company uses daily in its manufacturing processes about one million gallons of water pumped from the river, which on its return carries a large quantity of waste matter. The chief items of waste come from the use of about eighty cubic yards of river sand daily, 180 pounds of emery flour, about 100 pounds of rouge (from copperas), and a small amount of acid used in cleaning the glass. The resultant waste is dirty white in color and contains a large amount of solids. What wastes there may be from the other plants are also discharged into the river. A serious outbreak of gastrointestinal disorders followed by some fifty cases of typhoid fever which occurred in Wickboro

and Kittanning in the winter of 1906 and 1907 was thoroughly investigated by the Department and a report thereon will be found on page 894 of the Second Annual Report of the Commissioner of Health. The outbreak was occasioned by a sudden, excessive sewage pollution of the raw river water supply coupled with inefficient operation of the filters. The Department immediately took the necessary steps to prevent a recurrence of the trouble.

Kittanning, the county seat of Armstrong County, is an incorporated borough, 5,000 population, situated on the east bank of the Allegheny River forty-five miles from its mouth. It is essentially an industrial town. Among the principal industrial plants are the furnace and rolling mill of the Kittanning Iron and Steel Company with 350 employees producing about 100,000 tons annually of pig metal and muck bar, the Daugherty Brothers Brick Company, the Hay & Gallagher Foundry, the Elk and the Kittanning Breweries, the Pittsburgh Writing Machine Company, the Heilman Brothers Lumber Company, and the Claypoole Lumber Company. The Armstrong Water Company supplies the public in Kittanning as well as Wickboro the adjoining borough on the north. The supply for Kittanning is derived from the Allegheny River through a settling basin and filters before reaching the consumers. On January 13th, 1906, the Commissioner of Health issued a permit to the Citizens Water Company of Kittanning, now owned by the Armstrong Water Company, for the use of certain springs which furnish part of the present supply. A large number of private wells have been drilled to supply individuals and groups of houses. This well water is said to be of excellent quality and very abundant. The Kittanning Iron and Steel Company derives a private supply for industrial purposes from the river. The borough appears to have extensive sewerage facilities connecting most of the properties and there are few privies in use. The sewers are mostly on the combined plan with seven outlets into the river ranging in size from sixteen to forty-two inches. Three of the largest of these, twenty-four, thirty and forty-two inches respectively, discharge into the river above the water works intake. On October 5th, 1908, a permit was granted by the Commissioner of Health for the construction of certain sewer extensions. In this permit of 1908 the following discussion by the Commissioner of Health may be found:

"The attention of the local authorities is hereby called to the fact that the epidemic of typhoid fever and stomach disorders of the winter of nineteen hundred and six and seven has been attributed to the sewage pollution of the Allegheny River water, and that while the State Department of Health has done what it could to bring about the proper filtration of the public water supply of Kittanning and Wickboro boroughs, and will continue to exercise supervision thereover, nevertheless, it is all important that the discharge of sewage into the river above the water works intake should be discontinued and the borough officials should understand that it is the purpose of the State to require Wickboro Borough and Kittanning Borough to make changes in their sewer outlets at the earliest practicable moment and to this end said local authorities are urged to prepare the plans called for during the current season as early as possible."

"The Department is informed that Kittanning has about reached the constitutional limit of indebtedness and that it is not in a position to undertake at this time the erection of sewage purification works or the separation of sewage from storm water in the existing sewers. Accepting this as a fact, it does not appear to be true that the borough cannot afford to devise plans for an improved sewerage system and for the ultimate treatment of the sewage. If this were done and the plans adopted, then the local authorities could lay down lateral sewers from time to time as improvements were demanded, and do this in a way that would insure no blunders or the necessity of reconstruction of sewers in the future.

"The surcharging of the existing sewers during heavy rainfalls, indicates the desirability of further improvements in surface drainage. It is not possible to purify both sewage and storm water, and when sewage disposal works shall have been built at Kittanning, the household drainage only can be treated because of the prohibitive cost to treat mingled sewage and storm water. This is another reason why economy and efficiency dictate that comprehensive plans should be devised at the earliest possible moment and adopted. Since Kittanning and Wick-boro are practically one community and their interests are one with respect to the public water supply, the economies of the situation would dictate that the two towns join in the preparation of plans for improved sewerage and sewage disposal and this idea is heartily commended to the consideration of the local authorities.

"There would seem to be no objection to granting the right to the borough to build the Clay Alley combined sewer since it is always to be a storm drain, provided the borough exclude sewage from it, or if the sewage be admitted, it shall be under terms whereby the sewage may be excluded whenever this should appear desirable. There seems to be no reason also why the interests of the public health will not be subserved by granting the borough permission to fill in the gap on the line of the proposed thirty-inch sewer between McKean Street and the railroad. However, the necessity for the fifteen inch extension in Grant Avenue as a storm sewer is not apparent. This sewer should be laid as a sanitary sewer and if storm water be admitted it should be only temporarily and under conditions whereby such waters shall be excluded at any time the Commissioner of Health may determine it to be necessary."

Industrial wastes from the numerous manufacturing establishments are quite extensive.

Manorville, Armstrong County, is a borough of 600 inhabitants situated on the east bank of the Allegheny River three miles below Kittanning and about one mile above Ford City. A small planing mill and a few stores are the only business enterprises, the population being largely employed in Kittanning and Ford City. There is no public water supply, water for domestic purposes being derived partly from dug wells and partly from individual springs on the mountain side. In one instance fourteen families are supplied from springs which flow from an abandoned coal mine above the town. The Manorville Water Company, incorporated about eight years ago to supply the public with water derived from the Armstrong Water Company at Kittanning, has never been operative. Public and private sewers serve practically the entire population. There are eight public outlets to the river ranging in size from ten to twenty-four inches, and having street inlets for surface water. A number of private sewers discharge directly into the river.

Ford City, Armstrong County, is a borough with about 4,000 population, situated on the east bank of the Allegheny River just below Kittanning and Manorville and about forty-two miles from the mouth of the river. In 1890 its population was 1,225 and in 1900, 2,870. It is an industrial town with a number of large establishments including two plants of the Pittsburgh Plate Glass Company with about 2,500 employees, the Ford City China Company employing about 300, the Cook Pottery Works, and the Fisher Foundry and Machine Com-

pany. The borough has a municipal water system deriving its supply from the Allegheny River. Recently a "filter" crib was built which strains the water through about three feet or more of gravel. Previously two wells on the river bank of insufficient capacity were in service. The borough has a million gallon reservoir but water is pumped direct from the mains and the Pittsburgh Plate Glass Company has been given the right to use the reservoir in connection with its private industrial supply, which is raw river water. Valved connections permit the entrance of this water to the borough mains in cases of emergency. Public water is supplied very generally and there are few wells in use. The Farmers Building has a private supply from an air lift well. The Pittsburgh Plate Glass Company have a private industrial supply from the river using 12,000,000 gallons daily at its No. 4 plant and 2,500,000 gallons at its No. 5 plant. The town is divided into three sewer districts the upper two of which have combined systems with 48 inch and 54 inch outlets respectively and serving about 3,500 persons, practically all of the population of these districts. A permit was issued by the Commissioner of Health on June 10th, 1907, for the construction of a separate sanitary system in the lower district serving its entire population of about 500. This permit allowed the temporary discharge of sewage into the river until such time as other municipalities along the stream should be required to purify their sewage. The Pittsburgh Plate Glass Company returns to the river upward of 13,000,000 gallons daily of waste water which, from the nature of the plant, probably carries a large amount of insoluble, mineral matter in suspension and but little of an objectionable chemical or pathogenic character. The wastes from the other plants are practically of little importance.

(b) *Mahoning Creek Drainage Area.* Mahoning Creek rises in two branches, Mahoning Creek proper and the East Branch of Mahoning Creek, in a wilderness region of Chestnut Ridge in the western part of Clearfield County. These two branches flow in a general south-westerly direction until they meet just east of Big Run borough in the eastern part of Jefferson County. From here Mahoning Creek continues this southwesterly direction through Jefferson County to Goodville in northwestern Indiana County where it turns to the northwest and enters Armstrong County. The course of the Creek from here to its confluence with the Allegheny River near Mahoning City is extremely circuitous. Many of its loops are several miles in length and the general trend of the valley is either west or northwest across the stratification. At the eastern line of Armstrong County the basin is ten miles wide, narrowing steadily to the westward and confined to the hills directly bordering the stream. The stream bed has usually a thick covering of gravel, but in many places rock is exposed.

Little Mahoning Creek is the principal tributary of Mahoning Creek. This stream rises in many rivulets in the northeastern part of Indiana County and follows a general northwesterly direction to its confluence with the main stream at Goodville in the extreme northwestern corner of the county. It flows through a wide, rugged valley and has many tributaries.

The fall of the headwaters of Mahoning Creek is rapid, but between Independence and the Allegheny River, the total fall is 250 feet. This slope is nearly uniform, being slightly less rapid as the valley of the Allegheny River is approached. At the point of confluence with the Allegheny, the distance to the mouth of the Allegheny River is 56.2 miles and to the source of the Allegheny River about 252 miles. Mahoning Creek has been declared a public highway on account of the large lumbering business which was formerly carried on in its basin. A gauging taken at Mahoning on September 25th, 1908, shows the minimum discharge to be 19.91 second feet.

Rainfall records at Mahoning covering nine complete years and a total of twelve years give the following annual precipitation in inches: maximum 51.38, minimum 28.84, mean 35.83.

Mahoning Creek drains an area of 397 square miles including parts of Clearfield, Jefferson, Indiana and Armstrong Counties.

The surface of the eastern part of the basin is smooth, fertile, well watered and capable of profitable cultivation. In the central part of the basin, the creek flows in a deep, wide valley. A narrow divide trending east and west separates the waters of Mahoning Creek from Little Sandy Creek. South from the creek the region is an upland plateau, the top of which is 300 feet above the creek level, covered with shales and but little broken by ravines. The section north of the creek is quite as high but much diversified with hills and valleys. In the western part of the basin the immediate valley of Mahoning Creek narrows and is not entirely symmetrical, the western banks being much the steeper.

The total population of the basin is 44,770 divided in the following proportions: urban 27,200, rural 17,570. The rural population is approximately forty-four to the square mile.

The earliest settlements in this district were made along the Mahoning Creek where the surface is well adapted to cultivation. From 1830 to 1850 the population increased rapidly; after 1850 the growth was steady but less rapid on account of the destruction of the forest and partly because the commercial reverses at that time checked the lumbering business and stemmed the tide of immigration. The next decade showed a much smaller increase on account of the Civil War, but after 1870, in spite of the depression following upon 1873, there was a marked improvement, owing to the construction of branch

railroads which opened up to market the adjoining coal fields. All other industries at the present time are subordinate to coal mining and agriculture. Lumbering and manufacturing engage the attention of the people not actively interested in farming and mining operations.

The following municipalities are the only towns in the basin having a population of over 1,000: Punxsutawney, 10,000; Anita, 2,100; Florence, 2,000; Sykesville, 1,900; Eleanor, 1,500, and Adrian, 1,400.

Punxsutawney situated on Mahoning Creek is one of the oldest towns in this district having been laid out in 1818 or 1819. Its principal industries are the Punxsutawney Foundry and Machine Company, the Punxsutawney Brewing Company, the Punxsutawney Iron Company, the Elk Brewing Company, and the Star Iron Works.

Anita, Florence, Adrian, Rossiter, Sykesville, and Eleanor are all mining towns and their financial standing is dependent upon the mines in their immediate vicinity. All these towns send mine drainage into Mahoning Creek which has the characteristic color of waters receiving such drainage.

Mahoning Creek and its tributary streams are used to a limited extent for water power. The developments are small and are as follows: Jefferson County: Big Run, on Mahoning Creek; Ringgold, on Pine Creek. Indiana County: Smicksburg, on Little Mahoning Creek. Armstrong County: Putneyville, on Mahoning Creek.

The industrial activities of the region are varied. In general it may be said that the territory about the head waters is devoted mainly to coal and timber, but further down agriculture and coal mining are of the most importance, while natural gas is quite abundant. Big Run and Punxsutawney are the principal manufacturing towns both with industrial plants of various kinds. The tannery of the William Irvin Company at Big Run is, for the purpose of this study, the most important plant on the watershed and reference will be made to it further on.

The upper portion of the basin is traversed by a number of railroads following the stream and its principal branches, but from the junction of Little Mahoning Creek down to the point where the main stream enters the Allegheny River the watershed is virtually without railroad facilities. The aggregate railroad trackage is about a hundred miles.

The Lindsay Water Company derives water from Clover Run, a tributary of Big Run, and supplies it to the public in Big Run through the Big Run Water Company, serving about half the population, and to Punxsutawney through the Punxsutawney Water Company, also serving about half the population there. This supply is subject to contamination and is filtered under an order from the Commissioner of Health. The Cascade Coal and Coke Company has

a private system supplying a portion of the town of Sykesville with water from Bucks Run. The Clearfield Bituminous Coal Company has a private system supplying well water to the public in Rossiter, and United Coal Company at Anita and the Rochester and Pittsburgh Coal and Iron Company at Adrian have similar systems. At Sykesville the Cascade Coal and Coke Company derive an industrial supply from Big Run; at Big Run the Buffalo and Susquehanna Company use Mahoning Creek water for industrial purposes; and at Adrian an industrial supply is drawn from Little Elk Run by the Rochester and Pittsburgh Coal and Iron Company.

In the following Table XLII, are mineral analyses of Clover Run near Punxsutawney:

TABLE XLII.

Mineral Analyses of Clover Run near Punxsutawney.

Parts per Million.

Determination.	1909.	1909.
	by W. B. Scaife & Sons Co.	by Am. Water Softening Co.
Volatile and Organic,	6.0	.....
Silica,	6.0	.....
Iron and Al. Oxides,	Trace.	.....
Calcium Oxide,	12.0	.....
Magnesium Oxide,	2.0	.....
Sodium Oxide,	1.0	.....
Sulphuric Anhydride,	8.2	.....
Carbonic Anhydride (fixed),	1.9	.....
Carbonic Anhydride (free),	3.8	.....
Chlorine,	8.6	.....
Nitric Anhydride,	1.7	.....
Calcium Carbonate,	4.3	.....
Calcium Sulphate,	14.0	8.9
Calcium Chloride,	5.8	5.3
Calcium Nitrate,	2.6	.....
Sodium Chloride,	1.9	6.2
Magnesium Carbonate, .....	.....	0.9
Magnesium Chloride,	4.8	.....
Magnesium Sulphate, .....	.....	5.5
Alkalinity,	4.3	18.8
Total Solids,	45.3	31.5
Suspended matter,	1.7	.....
Free Carbonic Acid,	3.8	1.7
Incrusting Solids,	43.4	25.9
Non-Incrusting Solids,	1.9	6.2
Iron, Alumina, and Silicia, .....	.....	4.8

Mahoning Creek in Armstrong County, has been stocked with pike perch and the Little Mahoning in Indiana County, has been stocked with bass and yellow perch. Trout have been placed in some of the suitable streams.

It is estimated that a population of 12,910 persons contribute direct or indirect sewage pollution to the waters of Mahoning Creek, although the borough of Punxsutawney is the only town with a municipal system. Aside from mine drainage, which is very extensive,

the only industrial pollution of importance is contributed by the William Irvin Tannery at Big Run. In the tanning process at this plant 200 pounds of soda and 150 pounds of sulphuric acid are used daily, beside lime and the usual tannic acid. The wastes going to the creek here are the characteristic wastes from tanneries as considered more specifically elsewhere in this report.

Troutville, Clearfield County, population 450, is a borough situated near the western boundary of the county on high ground draining north and south to the East Branch of the Mahoning Creek and north to Stump Creek, one of its tributaries. It is a rural community with no industries, in a rich agricultural district with abundant coal, which however, is not largely mined in the vicinity. It has no public water supply, the inhabitants using water from private sources, including eighteen drilled wells, fifty-five dug wells and two springs. There is no public sewer system and but one individual private sewer which discharges sewage from a small hotel to Beaver Run. Each house has a privy and the soil being porous gravel, there is little evidence of overflow from them. Kitchen waste in several instances is discharged into the highway but generally to the ground.

Sykesville, Jefferson County, population 1,900, is a borough situated near the eastern county line on Stump Creek. It is about eight miles south of DuBois and seven miles southeast of Reynolds-ville, with both of which boroughs it has trolley connections. It is a mining town with a number of large operations in the vicinity. The Cascade Coal and Coke Company with about 500 employees operates coke ovens on Buck Run in connection with their mining operations. The Rochester and Pittsburgh Coal and Iron Company has a shaft near the borough line on Sugar Camp Run giving employment to about 200 persons. About half the inhabitants derive water for domestic purposes from wells, the remainder from a large number of springs. Several of these springs are controlled by private individuals and piped to two houses in the neighborhood. The Cascade Coal and Coke Company supplies its own tenement houses, including perhaps 200 persons with water from an intake on Buck Run. This company also derives an industrial supply from the same source for use at its coke ovens and mines. The borough has no public sewers, but a number of individual properties have private outlets to the runs. Kitchen waste is discharged largely to the ground, a great part finding its way to highways and runs. Surface privies are in general use and many of them are on the banks of the runs or swamp ground. The sanitary conditions of the borough are far from good and sewers are much needed.

The village of Eleanor is situated on Big Run about five miles north of Big Run borough. The village and intervening territory contain a total population of about 1,500. A large amount of mine

drainage is contributed to Big Run from this region. The Rochester and Pittsburgh Coal and Iron Company derives a private industrial supply from Laurel Run and Big Run.

Big Run, Jefferson County, population about 1,000, is a borough situated at the junction of Big Run and Mahoning Creek in the southeastern part of the county. Originally a lumber town, it is still largely dependent on the allied industry of tanning, although mining operations in the vicinity have aided its development markedly during recent years. Its industrial plants include the tannery of the William Irvin Company with a capacity of 200 or more hides daily, employing 65 hands, a lumber mill operated by the same company, employing 40 hands, a grist mill with five employees operated in part by water power installation on Mahoning Creek, a planing mill with ten employees, and a range boiler works with about thirty employees. The Big Run Water Company supplies about a third of the population, deriving its supply through the Lindsey Water Company from Clover Run, a branch of Mahoning Creek above Big Run, Punxsutawney is also supplied through the same Lindsey Water Company. Timber and mining operations on the watershed of Clover Run render the supply not above suspicion. A private water system supplies twenty families with water from a mountain spring and some fifteen families are supplied from numerous springs throughout the borough. The remaining population obtain water mainly from dug wells. The industries generally use public water but the mines have private industrial supplies. The Buffalo and Susquehanna Company has a private intake on Mahoning Creek near Big Run. There is no municipal sewerage system, but about eighteen houses are connected by private outlets to Mahoning Creek or the tail race from the mill. There are four cesspools and perhaps 175 privies in the borough, most of the latter with loose vaults, but apparently causing little or no pollution except their probable effect upon the private wells. On November 2, 1907, the Commissioner of Health issued a decree withholding from the borough permission to increase the pollution of Mahoning Creek by the construction of a proposed sewer. Aside from the sewage pollution contributed by the borough and the mine water coming from the numerous coal operations in the vicinity, the industrial wastes from the tannery of the William Irvin Company add extensive pollution to the water of the creek. The tannery treats hides and in the various processes uses equal amounts of extract and bark and about 150 pounds of sulphuric acid daily. Lime is used for dehairing and in bleaching about 200 pounds of soda a day are used. It is variously reported that from 13,800 to 23,100 gallons of liquid wastes are daily discharged from the tannery including water from hide soaking, lime water, bleach water, and spent tan liquids.

Rossiter, Indiana County, population about 2,100, is a village located in the northeastern part of the county near the boundary on Canoe Creek, a tributary of Mahoning Creek. It is a mining town dependent entirely upon the workings of the Clearfield Bituminous Coal Company. Water is supplied to the public by a system owned by the coal company and is derived from three artesian wells from which water is pumped to two reservoirs and distributed by gravity to the greater portion of the inhabitants. The town has no sewer system and privies are in general use, besides three cesspools. A few individual drains discharge sewage to the creek, and several privies contribute direct pollution. Kitchen waste almost universally is discharged on to the ground and thence into the highways or creek, mostly the former.

North Rossiter, Indiana County, population about 900, is a village practically adjoining Rossiter. It is without industries being purely a residential town for miners employed in the neighboring coal mines. It has no water works. A certain spring used by a portion of the population is liable to pollution by kitchen waste from two properties. There is no sewerage system and the privies that are universally used generally overflow to the highways and alleys, which also receive the greater part of the kitchen waste.

On Elk Run about five miles north of Punxsutawney and extending about two miles down stream, lies a series of four villages devoted entirely to mining, the inhabitants being employed in the numerous and extensive coal operations in this section. The villages are practically a continuous settlement and in order, beginning upstream, are: Florence, population 2,000; Anita, population 2,500; Crawfordstown, population 550; and Adrian, population 1,400. A trolley line from Punxsutawney to Reynoldsville extends through these settlements. None of the towns has a sewer system. The water supply of Florence is derived from individual drilled and dug wells and from springs. Overflowing privies are numerous and kitchen waste, garbage and refuse are deposited indiscriminately in the highways and runs. At Anita the United Coal Company supplies water pumped from a dug well to a portion of the population. Some fifteen or more families use a spring the remainder depending on wells. The same unsanitary conditions prevail here as noted above at Florence. At Crawfordstown the inhabitants depend upon dug wells for their water supply, and the same unsanitary conditions prevail as noted above. The village of Adrian is owned exclusively by the Rochester and Pittsburgh Coal and Iron Company which has extensive mines and 512 coke ovens. The company operates a system of water supply, the source of which is in two drilled wells pumped by compressed air to a 24,000 gallon reservoir. There is only one cesspool in the

town and a privy vault is provided for every five to eight families, and the sanitary condition is much better than that of the neighboring towns above. The coal company at Adrian derives a private industrial supply for its coal and coke operations from Little Elk Run. It is said that 60,000 gallons of water daily are used by 125 of its ovens.

Punxsutawney, Jefferson County, population about 10,000, is a borough located in the south central part of Jefferson County on Mahoning Creek. It is a manufacturing and mining community, depending largely on coal operations in the vicinity. Its industrial plants comprise the Punxsutawney Iron Works blast furnaces, the Star Iron Works, two large brick yards, the Eldred Glass Company's new plant, the Punxsutawney Beef and Provision Company, three machine shops, three planing mills, two flour mills, two breweries, and a refining plant. About one half of the people obtain drinking water from sources on private properties, often in close proximity to earth privy vaults in a porous, gravel formation. The Punxsutawney Water Company supplies water to the public, formerly from Mahoning Creek within the borough, but more recently from the Lindsey Water Company whose source is Clover Run, a tributary of Mahoning Creek at a point above Big Run borough. A filter plant was installed by order of the Commissioner of Health. The borough has a system of public sewers serving part of the municipality and having eleven outlets to Mahoning Creek ranging in size from ten to twenty inches, beside which there are some thirty-five private sewers into Elk Creek. There are also four private sewers and fourteen privies discharging on the banks or directly into the stream. In some districts kitchen wastes are discharged into the highways. Most of the public sewers were originally intended for sanitary purposes only, but have been used as combined sewers, thus being overtaxed and frequently backflooding into the properties connected to them.

Probably over 2,000 persons contribute sewage to Mahoning Creek at this point. The industrial plants in the borough discharge no manufactural wastes of importance but the mine waters from the numerous extensive operations in the vicinity yield large quantities of acid mine drainage, greatly affecting the condition of the stream.

In a decree relative to sewerage issued by the Commissioner of Health to Punxsutawney July 1st, 1909, the following discussion was set forth:

"The local authorities have not accompanied their application with detail plans and profiles. Neither have they filed in the office of the State Department of Health profiles of any of the sewers in the town. It is as impossible for the State officers to properly consider and advise with respect to the merits of a sewer design as it is for the local officials to do so without adequate information as a basis for consideration.

"There can be no doubt about the necessity for improved sewerage in the borough, but how best to remedy the evils and to do this in the most economical manner is a problem which demands thorough study, first by the local authorities and then by the State. It cannot be reasonably expected of the Governor, Attorney General and the Commissioner of Health that this high authority should approve a plan which may prove to be ill-conceived and require undoing in five, ten or fifteen years. The State Department of Health does not have before it the evidence to show that the borough of Punxsutawney has given a proper study to the problem.

"It appears that the sewers now existing are small in diameter because they were originally designed for sanitary conduits, but they have been turned into combined sewers temporarily perhaps so that what was intended to conserve the health of the community, has, if the representations be correct, proven to be a detriment to the health of the community.

"The first question naturally to be asked under the circumstances would be whether the interests of the public health do not demand that the sewers be restored to their use originally contemplated and whether other channels of proper size and otherwise suitable should not be provided for the removal of storm water.

"Furthermore, while it may be true, as alleged, that there are no towns along Mahoning Creek which derive their source of drinking water from the creek and while the acid mine drainage may kill the sewage organisms in the waters of the creek under ordinary conditions thereby making it quite improbable that pathogenic pollution reaches the Allegheny River from the Mahoning Creek valley much of the time, nevertheless it is also probable that there are weeks at a time during certain months of the year when sewage from Punxsutawney borough is discharged by the Mahoning Creek into the Allegheny River. Kittanning borough derives its source of supply from this river at a point a few miles below the mouth of Mahoning Creek and there have been very extensive epidemics of water borne diseases in Kittanning.

"It is probable that Punxsutawney will continue its existence after the coals shall have been exhausted from its vicinity and hence after the destruction of bacteria by acid mine drainage has ceased. One resource of the State is bound to increase in value as the years go by and that is the water supply. The health of the people and the purity of the waters of the State are vitally connected. No permanent public improvement relative to sewerage should be inaugurated in Punxsutawney that does not contemplate the preservation of the purity of the waters of the State ultimately even though temporarily for some good reason sewage be permitted to discharge into such waters. Pennsylvania's policy and that of many other states is to bring about ultimately the discontinuance of the discharge of all sewage into streams used subsequently as the source of public water supply. The lower Allegheny River is and must continue to be the source of supply to Greater Pittsburgh and this alone dictates the contemplation of the treatment sometime of Punxsutawney sewage.

"It does not seem to be practicable, owing to the prohibitive cost, to treat mingled sewage and storm water. The borough of Punxsutawney should study the problem of its surface drainage independently of the problem of sewerage for house drainage, and plans for the collection and treatment of all of the sewage of the borough should be prepared and submitted to the Commissioner of Health for approval and when the plans shall have been approved and finally adopted, then the borough may proceed, from time to time to build sewers in compliance therewith."

Smicksburg, Indiana County, population 250, is a small borough in the northwestern part of the county on Little Mahoning Creek about two miles and a half from its junction with Mahoning Creek. It is a rural community without industrial plants. The region produces considerable natural gas and is underlain with coal, although the only mining done is for local use. Water is derived from sixty-nine private drilled and dug wells and two springs. There is no sewer system, privies being in general use, several of them on the bank of a small run, and kitchen waste being generally disposed of to the ground. There is a small water power development here on Little Mahoning Creek.

Dayton, Armstrong County, population 1,000, is a borough situated on Glade Run about three miles from its confluence with Mahoning Creek. There are no industries of importance in the town, but natural gas and coal are abundant in the surrounding country and there is a colliery close by operated by the Dayton Coal Company. There is no public water system, dug wells and a few drilled wells supplying most of the inhabitants while a few depend upon several springs, one of them quite large and extensively used. There are no public sewers, but a large number of individual drains discharge kitchen waste and some sewage to the highways or the several runs which drain the borough. Privies are in general use, many of them causing direct pollution of the runs.

(c) *Typhoid Fever.* In Table XLIII are given the typhoid cases reported to the State Department of Health from 1906 to 1912 inclusive by the local authorities of the several places of importance in this division of the Allegheny River basin.

TABLE XLIII.

Typhoid Fever Cases Reported for the Section of the Allegheny Basin from Mahoning Creek to Crooked Creek, 1906—1912, inclusive.

Town.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
Adrian (Hosp.),	33	41	0	0	0	0	0
Big Run,	4	4	0	0	0	1	0
Punxsutawney,	36	39	23	11	21	11	9
Sykesville,	0	0	6	14	4	1	4
Smicksburg,	0	0	2	0	0	5	2
Appelwold,	1	0	0	1	6	0	0
Ford City,	3	0	5	17	1	14	1
Kittanning,	8	110	4	4	5	9	5
W. Kittanning,	1	0	0	0	0	3	8
Manorville,	1	0	0	0	0	0	0
Dayton,	0	0	7	14	6	0	0
Wickboro,	0	0	0	0	8	4	0
Rural Valley,	0	0	0	0	0	0	8
Yatesboro,* .....	.....	.....	.....	.....	.....	.....	.....

*42 cases in 1904.

Section 14.—Crooked Creek to Kiskiminetas River.

(a) *Crooked Creek Drainage Area.* Crooked Creek heads in two branches, Pine and Rayne Runs, in East Mahoning township among the hills of northern central Indiana County. These branches flow in a generally southwesterly direction joining at Gaibleton to form Crooked Creek. From here the creek continues southwesterly and crosses into Armstrong County at a point twelve miles north of the

Kiskiminetas, measuring along the county line. From this point the general trend of the valley is northwest or nearly parallel to the Kiskiminetas. The course of the stream, as its name implies, is tortuous and irregular; in point of fact, more than half its length is due to the frequent turns and bends.

The principal tributaries of Crooked Creek are from the north in which direction the larger part of the basin is situated; towards the south, the limits of the basin are confined very nearly to the hills which overlook the stream. Plum Creek, its main tributary rises in two branches in the northwestern part of Indiana County. These flow in a general southwesterly direction into Armstrong County and join about five miles above the junction with Crooked Creek. From this point, Crooked Creek flows in a southward course through a wide and deep valley, the hills bordering the stream usually about 300 feet high, then northwesterly to the Allegheny River.

Its run off is irregular and only capable of very limited use. The slope of the creek throughout its length of twenty-eight miles in Armstrong county averages ten feet to the mile and is regularly and evenly distributed, but the maximum slope of the headwaters is far greater than this. The water supply, though generally ample for such uses as are now made of it in turning a few grist mills, is subject to changes, which represent the extremes of severe droughts and high floods. Owing to the nature of the drained area the floods sometimes rise within a few hours filling the creek banks and subside again nearly as quickly. The mean annual rainfall is between forty and forty-five inches.

Crooked Creek drains an area of 280 square miles, embracing parts of Armstrong and Indiana counties, the basin presenting a considerable variety of topographical aspects. The hills immediately bordering the stream frequently present high vertical cliffs on both sides; at other places the creek flows through a broad valley with meadow lands stretching with easy slopes to the base of the hills. Usually the conditions are a steep hill on one side and a more gentle declivity on the other. On the tops of these hills are the uplands, the summits of which are often 500 feet above the creek level. The hills of this region are invariably benched; so also are some of the lower hills but the benches there are less distinct. The geological structure of the Crooked Creek region consists of a series of shallow synclinal basins separated by low anticlinal arches. Sandstone exists in boundless profusion, much of it being valueless, and extensive deposits of fire clay and limestone are also found. This region was formerly a wilderness of oak, the greater part of which has been removed in clearing for farms, the remaining timber in the low lands being chiefly chestnut and oak, and in the up-lands white oak.

The total population of the basin is 12,370 divided into the following proportions: urban 3,260, rural 9,110. The rural population is approximately thirty-three to the square mile.

There are no important cities on the shed, the largest town, Ernest, in Indiana County, having a population 1,800. This is an unincorporated coal settlement owned by the Jefferson and Clearfield Coal Company.

The only water power installations on Crooked Creek or its tributaries are small installations on Plum Creek at Elderton and on Crooked Creek at South Bend, both in Armstrong County. Industrially agriculture and coal mining are the paramount interests of the drainage area with some production of natural gas. Beside the coal operations there are no industrial plants of importance. The Crooked Creek watershed in Armstrong County has no railroads; but in Indiana County the B. R. & P. R. R. crosses the territory with a branch from Creekside to Indiana, passing through Ernest, the total trackage being about twenty-five miles. Crooked Creek is not used for domestic water supply except that at Ernest the Jefferson and Clearfield Coal Company draws water from McKees Run which is filtered before it is supplied to the consumers. The only other public water supply is that of the Marion Center Water Company which derives water from springs. The Jefferson and Clearfield Coal Company's water system at Ernest is used for industrial purposes at the mines and coke ovens, but otherwise there is no industrial supply in the region. There are no public sanitary sewerage systems in this territory and but few private sewers. Beside domestic sewage, the only pollution of importance on the watershed is contributed by the coal mines. There are twenty mines, the drainage from nine of which is pumped and this amounts to 2,650 gallons a minute; the other eleven mines have natural drainage and discharge 805 gallons a minute.

The State Fish Commission has stocked Crooked Creek and some of its tributaries with yellow perch, bass and pike perch.

Marion Center, Indiana County, population 400, is a borough in the north central part of Indiana county at the head waters of Pine Run, one of the upper tributaries of Crooked Creek. It is a rural community, its one industry being a large grist mill. The Marion Water Company supplies water to about ten families with spring water derived from a bluff overlooking the town, the remaining population depending on a few individual springs and about seventy-seven wells, mostly dug. There are no public sewers and only a few private sewers serving a dozen or more families. The remaining population use privies, the greater part unlined. Kitchen waste disposal is to the ground and to Pine Run.

Creekside, Indiana County, is a borough situated in the western part of the county on Crooked Creek. The business interests of the place are all centred about the mining of coal which is extensively carried on in the immediate vicinity. Natural gas, formerly found and used here, has given out and the wells are abandoned. A private water company recently incorporated as the Creekside Water Company, supplies perhaps a third of the population, the average consumption being about 9,000 gallons a day, from five springs south of the borough, the remaining population deriving water from six drilled wells and thirty-two dug wells. The borough has no public sewer system, but there are some nine private sewer outlets serving individual properties. Kitchen waste is largely discharged to the ground and to highways and runs. Garbage and rubbish are dumped into a ravine which drains directly to Crooked Creek. Privies are in general use, being for the greater part dug in gravelly soil.

Ernest, Rayne township, Indiana county, population 1,800, is an unincorporated coal town four miles north of Indiana and about a mile southeast of Crooked Creek at Creekside, to which stream its drainage runs by way of McKees Run. The surrounding country is wooded and the extensive mining operations of the Jefferson and Clearfield Coal and Iron Company are the only interests. In connection with its mines, the company operates 278 coke ovens. The 255 homes in the village are all owned by the coal company which supplies them with water pumped from McKees Run, filtered, and to some extent from two drilled wells. This water is also used for industrial purposes. The town has no sewers except two short lines serving a few families. The privies which are in general use are mostly dug in hardpan and frequently overflow, causing, together with the kitchen wastes, a decidedly unsanitary state of affairs in the highways and along the banks of the run.

Shelocta, Indiana County, population 110, is a small borough near the western boundary of the county on Crooked Creek. It is in a rich farming country, and coal is found in abundance with mining operations near by. Each of the thirty residences in the borough has its own dug well. The borough has two public storm sewers, but no sanitary sewers except a few from individual properties. Privies are in general use, a few of them being on the banks of the creek and kitchen waste is discharged on the ground and to ditches and highways or the run.

Atwood, Armstrong County, population 160, is a borough situated in the eastern part of the county on Plum Creek, a tributary entering Crooked Creek near the county line. It is a rural community with no industries but extensive coal operations are carried on in the vicinity. Water for domestic use is obtained from individual

sources including nine springs, nine dug wells and twenty-two drilled wells. Six properties have individual private sewers but there are no public sewers, each house having a board lined or unlined privy. But three properties here appreciably pollute the water course.

(b) *Along Allegheny River.* From its point of confluence with Crooked Creek, the Allegheny River flows in a southwesterly direction a distance of nearly eleven miles to the extreme southwestern corner of Armstrong County where it is joined by the Kiskiminetas River. The banks along the stream are steep and high but back from the river are sloping hills on either side; the slopes and uplands of these are covered with farms. During this part of its course rocks are seldom absent from the shoals, often lying partially-buried in the gravel and proving dangerous obstructions to navigation. The total population of this section is 3,740, divided as follows: urban 800, rural 2,940.

This section of the Allegheny River has been stocked with bass, yellow perch, pickerel and pike perch.

The dominant industries along this section of the river are coal mining and the manufacture of clay products, other industries being of little or no importance except farming. Aside from the numerous small operations there are nine coal mines of importance and the coal working industry centers about a large plant at Johnetta, commonly known as White Rock. The Allegheny Division of the Pennsylvania Railroad follows the east bank of the river throughout the section a distance of about eleven miles. The only town of importance, Johnetta, has no public water system, the inhabitants depending upon springs and driven wells for domestic purposes. The United States Sewer Pipe Company at this place derives a supply for their plant from springs. There are no public sewer systems, but the borough of Johnetta directly or indirectly contributes considerable domestic sewage. The total urban and rural sewage polluting population in this division is estimated at 1,240 persons. Mine water is the principal industrial polluting factor. Of the nine mines investigated, one is pumped, 200 gallons a minute being discharged, and eight have natural drainage discharging 440 gallons a minute.

Johnetta borough, Armstrong County (White Rock Railroad station) situated on the eastern bank of the river about thirty-three miles above Pittsburgh and about three miles above the mouth of the Kiskiminetas River, has an estimated population of about 800 depending exclusively for employment upon the works of the United States Sewer Pipe Company. The plant is situated along the river the town extending up the bluff to the hills above. The plant employs about 500 men, manufacturing brick and sewer pipe and mining coal. There is no public water supply system, the population deriving their water supply for domestic uses from driven wells and

springs. The sewer pipe company also derives water for use at its plant from springs on the hillside. There is no public sewer system but there are nine or more private sewers discharging into the river, five of which come from the works of the sewer pipe company. Three of these are twenty-four inches and two twelve inches in diameter. Kitchen wastes are commonly deposited on the ground and the general conditions are far from sanitary. A few of the houses which are connected with private sewers have baths, closets, etc. The industrial wastes from the sewer pipe works are not of sanitary importance.

(c) *Typhoid Fever.* In the following tabular statement appear the cases of typhoid fever in this section of the Allegheny River basin that have been reported by the local health authorities to the State Department of Health for the years 1906 to 1912 inclusive:

Typhoid Fever Cases Reported for the Section of the Allegheny Basin from Crooked Creek to Kiskiminetas River, 1906—1912, inclusive.

Town.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
Johnetta,	0	1	7	2	3	0	1
Elderton,	6	0	0	1	0	1	0
Creekside,	0	0	1	0	1	2	1

Section 15.—Kiskiminetas River to (Brilliant) Pittsburgh.

(a) Kiskiminetas River Drainage Area.

1. General Description of the River and Its Main Tributaries.

The name Kiskiminetas, said to mean "Make Daylight," in the language of the aboriginal tribes which inhabited its banks, is confined to the reach of the river below the junction of its two main branches, the Conemaugh and Loyalhanna, a few miles east of the Armstrong County line.

The Conemaugh rises in numerous rivulets in the southeastern portion of Cambria County and flows with many sharp turns and bends in a southwesterly direction to Johnstown. Here the river turns northwest and continues this general direction to its confluence with the Loyalhanna near Saltsburg where they form the Kiskiminetas. The head waters of this stream flow in deep gorges with high steep banks. The country drained consists mainly of woodlands, covered for the most part with a scrub growth, but there are a few upland farms on some of the plateaus. From Johnstown the Cone-

maugh River enters a deep, narrow, winding gorge, through Laurel Ridge, the most westerly range of the Alleghenies. The precipitous banks are covered with fragments of shale and sandstone which have slid down from the cliffs above on both sides of the river. These cliffs extend over 1,000 feet above the bed of the river and show plainly the structure of the mountain, forming as they do a regular arch about five miles wide. Issuing from the gorge the river flows between high, steep banks through open but rather broken country. The hills bordering the river are from 300 to 400 feet high and are quite uniform and regular except at Elders Ridge where they rise much higher. Back from the river the general surface of the country rises very gradually and merges into an elevated plateau. The country is very much broken by small hills and valleys but the topography presents in substance one broad inclined plane tilted slightly toward the southwest. The main stream cuts transversely across the Ligonier Valley exposing a natural geological section embracing 2,000 feet of rocks.

The total population of the basin of Little Conemaugh River above South Fork is 15,690 divided as follows: urban 8,760, rural 6,930.

The total population of the basin of the South Fork of the Conemaugh River above South Fork is 3,590, divided as follows: urban 650, rural 2,940.

The total population of the Kiskiminetas basin above Johnstown 30,950, divided into the following proportions: urban 19,460, rural 11,490.

Gaugings taken at South Fork on September 23, 1908, showed the minimum discharge of the Little Conemaugh and the South Fork of the Little Conemaugh to be 9.40 and 5.52 second feet respectively. A gauging taken at Johnstown on September 23, 1908, showed the minimum discharge of the Little Conemaugh to be 21.97 second feet.

Black Lick Creek, the main tributary entering the Conemaugh from the north drains an area of 403 square miles. It rises in Cambria county and flows in a general westerly direction to its confluence with the Conemaugh. The headwaters of this stream are in woodlands and during the first part of its course it flows through a steep gorge, strewn with boulders, with walls about 400 feet high. The flow here is very swift but the valley soon widens until the banks are but five feet high and the flow is less rapid. At its junction with the Conemaugh, Black Lick Creek is about seventy-five feet wide and has a yellow color, due chiefly to drainage from coke ovens at Coral and Graceton, while the Conemaugh itself is about 200 feet wide and its waters are a dark brown. Two Lick Creek and Yellow Creek, the main tributaries of Black Lick Creek flow through flat,

well farmed valleys with rolling hills on either side. Yellow Creek at its junction with Black Lick Creek is about forty feet wide and stained a brownish yellow color, the result of mining operations. The total population of the watershed of Black Lick Creek above Black Lick is 28,000 divided as follows: urban 17,830, rural 10,170.

Stony Creek, the largest tributary of the Conemaugh from the south, rises in the eastern part of Somerset county and flows in a general northerly direction to its confluence with the Conemaugh River at Johnstown. The valley of this stream is narrow and steep with high bluffs on either side and is strewn with boulders. Stony Creek is both muddy and rapid and the main stream, as well as its tributaries, is stained by sulphur deposits from the many mines along its course and on its tributaries. A gauging taken at Johnstown on September 23rd, 1908, showed the minimum discharge to be 11.95 second feet. The total population of the basin of Stony Creek above Johnstown is 21,500 divided as follows: urban 10,650, rural 10,850.

Loyalhanna Creek rises in the southeastern corner of Westmoreland county and flows northwest to Latrobe; here it changes its direction to west of north to Saltsburg where, in its confluence with the Conemaugh, the Kiskiminetas River is formed. The headwaters of this creek are numerous small runs which flow with high velocity through deep gorges. The course of the creek below Latrobe is very sinuous and the flow becomes gradually less rapid as the stream nears the Kiskiminetas. The valley of the Loyalhanna is a broad one with wooded bluffs found along the stream and open farming country beyond. The creek and its tributaries are badly stained by mine drainage which enters them all along their courses. A gauging taken at Saltsburg on September 24, 1908, showed the minimum discharge to be 10.72 second feet. The total population of the Loyalhanna Creek basin is 32,260, divided as follows: urban 14,110, rural 18,150.

From its origin at the confluence of the Loyalhanna and the Conemaugh, the Kiskiminetas flows with many long bends in a general northwesterly direction to the Allegheny River at Kiskiminetas junction. The valley of the river near the confluence of the Loyalhanna and Conemaugh is fairly wide and well formed but narrows as the Allegheny is approached. The river is about 200 feet wide at its mouth. Farm lands are found all along this part of its course. This valley presents a succession of steep slopes broken by frequent lateral ravines. The slopes are from 300 to 400 feet in height and merge into rolling uplands which rise 100 feet higher. On this plateau there is some excellent farming country situated at an elevation of 1,100 to 1,200 feet above sea level. The topography is governed by the geology. Where the river is crossed by the anticlinals the valley narrows into a gorge; where crossed by the synclinals, it

widens and expands, the hills on both sides retiring with more easy slopes towards the uplands. Moreover, to the same causes, the frequent long bends in the river are attributed. The bed of the river in this section has a shallow covering of gravel and rounded pebbles, chiefly sandstone and limestone and fragments of coal and slate. A high plateau divides the waters of the Kiskiminetas and Crooked Creek. The average volume of water from the Kiskiminetas is small, considering the extent of territory drained by it, but affords a superb water power, ample, abundant and obtainable at small cost. On either side of the Kiskiminetas at its mouth are steep, rounded, wooded hills with farmlands both to the right and left. There are many coal mines along its course and its waters are badly stained by mine drainage.

The Kiskiminetas drains an area of 1,846 square miles, in Westmoreland, Armstrong, Indiana, Somerset, and Cambria counties. Although draining a large area its flow is proportionately small. Gaugings of the flow of the river by the Water Supply Commission taken at a regular gauging station at Avonmore, show the minimum discharge over a period of nineteen months to be sixty second feet. The total population of the Kiskiminetas basin above Avonmore is 215,720 divided as follows: urban 144,040, rural 71,680.

Kiskiminetas Junction, the point where the Kiskiminetas joins the Allegheny River, is 30.2 miles from the mouth of the Allegheny and about 278 miles from the source of the Allegheny. The total population of the basin is 239,270 divided into the following proportions: urban 158,570, rural 80,700.

The total rural population is approximately forty-four to the square mile.

In the Kiskiminetas basin there are twenty-nine cities having a population of over 1,000, the largest of which will be fully described below.

Rainfall records taken at Johnstown, Saltsburg, and Freeport show the annual precipitation in inches to be as follows:

	Years of Complete Records.	Total Period of years Covered.	Precipitation in Inches.		
			Maximum.	Minimum.	Mean.
Johnstown,	23	26	57.39	37.55	47.58
Saltsburg,	11	18	58.25	35.00	48.35
Freeport,	27	30	57.43	30.83	41.93

Johnstown with a population of 60,000 is the largest municipality in the Kiskiminetas basin. It is located at the confluence of Stony Creek and the Conemaugh River.

Latrobe, a mining and manufacturing community with a population of 10,000 is situated in the Loyalhanna Valley in the north central part of Westmoreland county.

Indiana borough has a population of 7,000, is the county seat of Indiana county, and is situated in the south central part of this county on a branch of Two Lick Creek.

Windber is situated in the northern part of Somerset county on Paint Creek, a tributary of Stony Creek. It has a population of 5,000 and is a thriving mining town of recent origin.

South Fork has a population of 4,500 made up principally of foreign miners. It is situated in south central Cambria county at the junction of the two principal branches of the Conemaugh River, the Little Conemaugh and the South Fork.

East Conemaugh is a railroad and manufacturing community immediately east of Johnstown on the Little Conemaugh River and has a population of 4,050.

Blairsville is a municipality of about 3,500 located in the extreme south central part of Indiana county on an elevated plateau at the base of which is the Conemaugh River.

2. General Description of Natural Resources, Industrial Development, Water Supply and Sanitation.

Coal and water are the two chief resources of this division of the Allegheny basin although the soil is susceptible of greater utility.

Nine water power developments have been noted in the basin, for the most part operating grist mills or planing mills and of small size. On the Little Conemaugh River or its tributaries above South Fork there are installations at Ebensburg, Wilmore, Summerhill, and Ehrenfeld, all in Cambria county. At or near Stoyestown, Somerset county, there is one installation on Beaver Dam Run and three on Stony Creek, one of the latter developing thirty horsepower at Kantner. At Black Lick village, Indiana county, there is a small development on Black Lick Creek.

In the early days the Kiskiminetas was an important artery of navigation forming the principal means of communication between this region and Pittsburgh. Following the use of canoes and rafts the keel-boat came into service about 1816 when a large number of these boats were used for transportation of salt from Saltsburg to Pittsburgh and points beyond down the Ohio and Mississippi Rivers. In 1826 the State authorized the construction of a canal from the mouth of the Kiskiminetas River to Pittsburgh. This was built and further extensions made to Blairsville and later to Johnstown. A railroad for transporting boats over the Allegheny mountains from Portage to Hollidaysburg, was built and the canal transportation system from Pittsburgh to Philadelphia was finished in 1834. The portion from Johnstown to Pittsburgh was discontinued in 1870, when railroad transportation crowded out and superseded the canals.

The industrial activities of the basin are centered around and dependent upon the vast mineral resources found here in exceptional

abundance. Enormous deposits of bituminous coal primarily make the field especially attractive for industrial development in the production of steel and its products. Low grade iron ore, found in many places, was formerly refined in the old charcoal furnaces long since abandoned in the march of progress. At Johnstown, however, an extensive deposit of high grade iron ore supplied the furnaces there until a recent date. Coal is found in nearly all portions of the basin and the mining and preparation of it as coal or in the form of coke is a vast industry as noted elsewhere. The production of steel and its finished products predominates in and around Johnstown, as well as at Avonmore, Leechburg, Saltsburg, and Vandergrift. Important plants are also found at other points. Glass is manufactured at Indiana, Latrobe, Derry, Blairsville, and Saltsburg. Clay is an important mineral resource and its products, bricks, tiles and china-ware are produced extensively at Latrobe, Seward, Garfield, Bolivar, Derry, and Hyde Park. The manufacture of woolen goods, paper, and flour is carried on at several points.

With the growth of manufacturing and the development of the resources, railroads have come into existence and follow closely many of the principal tributaries as well as the river itself. The Pennsylvania Railroad has about 360 miles, the Baltimore and Ohio thirty-two miles, the Buffalo, Rochester and Pittsburgh about eighteen miles, the Ligonier Valley, ten miles, and other roads, twenty-five miles, making a total of some 445 miles of main lines within the Kiskiminetas River basin.

The domestic water supplies in the many cities and towns are derived largely from surface sources. Springs and wells, both dug and drilled, are largely used however. Municipal ownership in this region is rare, there being but four places where there are publicly owned supplies namely: Ebensburg, which has a spring supply, and Ligonier, Blairsville, and Saltsburg with surface supplies. These represent a total population of about 10,000 persons, not all of whom however, use the public water. There are thirty-nine places supplied with water by corporations. Ten of these, representing a total population of about 13,000 persons, are supplied with water derived from springs and wells, and in three of these cases the supplies are filtered. The remaining twenty-nine places are supplied with surface water, the supplies for four of the places being filtered. These twenty-nine places represent a total population of about 122,000 persons, not all of whom, however, use the public supply.

Industrial water supplies are obtained and used by many of the manufacturing establishments and nearly all of the large plants have their own supplies. This also applies to the coal and coke operations. Private industrial supplies are obtained at the following places among others:

KISKIMINETAS BASIN.

Private Industrial Supplies of Water.

Place.	County.	Source.	Remarks.
Jenner,	Somerset, ...	Quemahoning Creek,	Somerset Coal Co.
Vintondale, ...	Cambria,	Black Lick Creek (North Branch),	Black Lick Water Co. sells to Vinton Colliery Co. 500,000 gallons daily for steam and for washing coal for coking.
Josephine,	Indiana,	Well & Black Lick Creek,...	Furnace Water Co. supplies the Josephine Furnace and Coke Co. for steam and coking.
Graceton,	Indiana,	Springs and auxiliary from Two Lick Creek.	Graceton Coke Co. 8,000,000 gals. daily used for washing coal.
Coral,	Indiana,	Springs and auxiliary from Two Lick Creek.	Joseph Wharton Coal & Coke Co. Large quantities used for washing coal.
Johnstown, ...	Cambria,	Stony Creek, and Hineckston Run, small tributaries of Conemaugh River.	Manufacturers Water Co. supplies various plants. Cambria Steel Co. Greenbrier Water Co. supplies 6,000 gals. daily to Johnstown Pressed Brick Co. Various other plants.
Derry,	Westmorel'd,	Drilled wells Ethel Springs Run.	Locomotive and steam use.
Saltsburg,	Indiana,	Conemaugh River,	American Sheet and Tin Plate Co., 100,000 gallons daily.
Vandergrift, ..	Westmorel'd,	Kiskiminetas River,	American Sheet and Tin Plate Co. 49 million gals. daily.
Hyde Park, ..	Westmorel'd,	Kiskiminetas River,	United Engineering and Foundry Co.
Leechburg, ...	Armstrong, ..	Kiskiminetas River,	American Sheet and Tin Plate Co. 150,000 gals. daily.
W. Leechburg	Westmorel'd,	Kiskiminetas River,	American Sheet and Tin Plate Co. 300,000 gals. daily.
			West Leechburg Sheet and Tin Plate Co.

Table XLIV shows the mineral properties of the Kiskiminetas River at Apollo and the Conemaugh River at Blairsville and Johnstown.

TABLE XLIV.

Mineral Analyses of Kiskiminetas River Water at Apollo and the Conemaugh River at Blairsville and Johnstown.

By the Wm. B. Scaife & Sons Laboratory.

Parts per Million

Determination.	At Johnstown July, 1906.	At Blairsville May, 1909.	At Apollo July, 1908.
Volatile and Organic,	6.0	29.0	19.7
Silica,	2.6	7.7	16.2
Iron and Al. Oxide,	6.0	4.3	18.0
Calcium Oxide,	34.2	20.4	65.0
Magnesium Oxide,	11.0	8.6	25.8
Sodium Oxide,	11.8	5.3	22.9
Sulphuric Anhydride,	69.8	44.5	186.7
Carbonic Anhydride (fixed),	None.	None.	.....
Carbonic Anhydride (free),	11.2	11.2	20.7
Chlorine,	13.6	7.4	12.0
Nitric Anhydride,	Trace.	0.8	1.7
Calcium Sulphate,	82.1	49.9	157.3
Magnesium Sulphate,	32.8	22.6	77.5
Magnesium Chloride, .....	.....	1.9	.....
Magnesium Nitrate, .....	.....	1.2	.....
Sodium Sulphate, .....	.....	.....	26.2
Sodium Chloride,	22.6	9.9	19.7
Sodium Nitrate, .....	.....	.....	2.7
Acidity as H ₂ SO ₄, .....	.....	.....	33.5
Alkalinity,	None.	None.	.....
Total Solids,	152.3	126.5	377.7
Suspended matter,	15.7	4.3	0.9
Free Carbonic Acid,	11.2	11.2	20.7
Free Sulphuric Acid, .....	.....	.....	32.5
Inerting Solids,	130.5	87.6	289.2
Non-Inerting Solids,	22.6	9.9	48.6

Table XLV shows the acidity of the streams above Johnstown upon which extensive mining operation occur and the alkalinity of the Conemaugh River below these streams and the acidity of the lower portion of the Kiskiminetas River receiving the drainage from the major portion of the entire watershed, made by the laboratories of the Water Bureau of the city of Pittsburgh.

TABLE XLV.

Acidity and Alkalinity Tests by Chemists of Water Bureau of City of Pittsburgh
Parts per Million.

Place.	Date of Sample.	Acidity.	Alkalinity.
Near Johnstown:			
Stony Creek,	Aug. 24, 1909, ..	4.0	.....
Stony Creek,	Aug. 24, 1909, ..	42.0	.....
Clapboard Creek,	Aug. 24, 1909, ..	159.0	.....
Cambria Steel 12 in. drain,	Aug. 24, 1909, ..	28.0	.....
Near Windber,			
Run above,	Aug. 27, 1909, ..	132.0	.....
Creek Mine No. 36,	Aug. 27, 1909, ..	75.0	.....
Mine Waste No. 36,	Aug. 27, 1909, ..	70.0	.....
Mine Waste No. 35,	Aug. 27, 1909, ..	68.0	.....
Creek below No. 35,	Aug. 27, 1909, ..	87.0	.....
Paint Creek,	Aug. 27, 1909, ..	172.0	.....
Stony Creek above Paint Creek,	Aug. 27, 1909, ..	3.0	.....
Stony Creek below Paint Creek,	Aug. 27, 1909, ..	111.0	.....
Conemaugh River:			
Above Clapboard Run,	Aug. 24, 1909, ..	.....	4.0
Above dam,	Aug. 24, 1909, ..	.....	6.0
Below dam,	Aug. 24, 1909, ..	.....	8.0
Above Johnstown,	Aug. 24, 1909, ..	.....	22.0
Below Cambria Steel 12 in. drain,	Aug. 24, 1909, ..	.....	7.0
Below Cambria Steel blast furnace,	Aug. 24, 1909, ..	.....	27.0
Below Cambria Steel blast furnace,	Aug. 24, 1909, ..	.....	8.0
Below Cambria Steel blast furnace,	Aug. 24, 1909, ..	.....	6.0
Below Cambria Steel blast furnace,	Aug. 24, 1909, ..	.....	14.0
Below Cambria Steel blast furnace,	Aug. 24, 1909, ..	.....	46.0
Below Stony Creek,	Aug. 24, 1909, ..	.....	45.0
At Coopersdale,	Aug. 27, 1909, ..	7.0	.....
At Blairsville,	Aug. 27, 1909, ..	7.0	.....
(Magee's Run, mouth—Blairsville),	Aug. 27, 1909, ..	33.0	.....
Kiskiminetas River:			
At mouth,	Aug. 26, 1909, ..	66.0	.....
At mouth,	Aug. 26, 1909, ..	67.0	.....
Above Lecchburg,	Aug. 26, 1909, ..	52.0	.....
West Apollo,	Aug. 26, 1909, ..	39.0	.....
Above Beaver Run West Apollo,	Aug. 26, 1909, ..	45.0	.....

The principal polluting factors are domestic sewage and industrial wastes and both are very extensive in the Kiskiminetas River basin. The sewage pollution is somewhat offset by the acid wastes from mines and manufacturing plants during low water periods.

Domestic sewage is contributed by a large population. Out of a total urban population of about 159,000, living in sixty-four cities, boroughs and villages, there are twenty-four places which have public sewers, serving all or a part of these towns. In these twenty-four places there are 123,000 persons. Many of these and other places have pollutions other than by way of the public sewers and it is estimated that the total sewage polluting population is about 144,500, of which 126,500 reside in towns and 18,000 in the rural districts. Indiana borough, population 7,000, and Derry borough, popu-

lation 2,900, have sewage disposal plants for the treatment of the public sewage. These two places, as well as Ligonier, population 2,500, and Westmont, population 1,500, have separate sanitary sewer systems.

The industrial wastes, reaching the waters of the Kiskiminetas River and its tributaries, are very extensive, by far the largest being coal mine drainage. Associated with this and of further serious importance, on account of the large amount of finely divided coal carried in suspension and deposited in the stream below, are the wastes from washeries in which coal is prepared for coking, notably at Vintondale, Josephine, Graceton, and Coral on Black Lick Creek and its tributaries, and in the district above Latrobe on Loyalhanna Creek. Manufactural wastes have been noted at the following places, among others:

INDUSTRIAL WASTES.

Place.	County.	Stream.	Remarks.
Ebensburg, ...	Cambria,	Small tributary of Little Conemaugh River.	Woolen Mill.
Franklin,	Cambria,	Conemaugh River,	Oily wastes from Cambria Steel works.
Nant-y-glo, ...	Cambria,	Black Lick Creek,	Chemical plant nearby.
Indiana,	Indiana,	Stony Run,	Woolen Mills, Brewery, Tannery.
Latrobe,	Westmorel'd,	Loyalhanna Creek,	Paper Mill (wastes including rag washing), Woolen Mill (dyes), Slaughter House Wastes.
Johnstown, ...	Cambria,	Conemaugh River,	Industrial wastes of various kinds—extensive.
Blairsville, ..	Indiana,	Sulphur Run,	Blairsville Enamel Co. (Wastes reported filtered).
Avonmore, ...	Westmorel'd,	Kiskiminetas River,	Alcania Co. (Tin Plate) (Sulphuric acid wastes).
Vandergrift, ..	Westmorel'd,	Kiskiminetas River,	American Sheet and Tin Plate Co. (Muratic & Sulphuric acid wastes).
Leechburg, ...	Armstrong, ..	Kiskiminetas River,	Pittsburgh Shovel Co. (Sulphuric Acid Wastes).

3. Survey of Little Conemaugh River Sub-Basin.

On the Little Conemaugh River sub-basin above South Fork Creek tributary are the boroughs of Cresson, Lilly, Portage, Ebensburg, Wilmore, Summerhill, and the village of Ehrenfeld.

Cresson, Cambria County, population 2,000, is a borough situated in the eastern part of the county on the divide between the Susquehanna and the Allegheny River watersheds, the greater portion of the borough draining to the latter by way of Laurel Run, the head waters of the Conemaugh River. It is a railroad centre, being the junction point between the mainline and two branch lines of the Pennsylvania Railroad. Its inhabitants are largely employed by the railroad or the Pennsylvania Coal and Coke Company, whose operations are handled from division headquarters at this point. The

Cresson Machine and Car Company's shops are located in Sankertown, an adjoining borough on the Susquehanna watershed and give employment to some of the inhabitants of Cresson. Cresson borough has many surface springs and one-half the population take water from driven wells, dug wells or springs. The remaining inhabitants are supplied by two water companies, the Cresson Water Company supplying about 500 persons with water from mountain springs augmented in the summer by a drilled well, and the Rebecca Water Company, whose source is three springs located within the borough. The Commercial House has a private supply from a spring on the hillside. There is a public system of sewers and several private sewers in the borough discharging into Laurel Run. Privies abound and there are cesspools of the percolating type. The borough constructed a sanitary system of sewers with a twenty-four inch outlet into Laurel Run below the borough line. On August 16th, 1907, the Commissioner of Health issued a permit for this system subject to certain conditions and stipulations, one of which required that plans for sewage disposal be prepared and submitted to the Commissioner of Health for approval.

Lilly, Cambria County, population 1,600, is a borough dependent for its financial support on extensive coal operations in its vicinity. It is situated on the Little Conemaugh River in the eastern part of Cambria County and about three miles below its source at Cresson. Water is supplied to the inhabitants of the borough by the Mountain Spring Water Company which is operated by the Summit Water Supply Company. The supply for Lilly is derived from an intake on Bear Rock Run. The borough has a combined system of public sewers discharging through a twenty-four inch pipe into the Little Conemaugh River below the borough, to which there are said to be some sixty connections. In addition to this system there are said to be ten private sewers discharging to Bear Rock Run, three to the Little Conemaugh and eleven privies draining into Bear Rock Run. Beside the sewage pollution noted the stream at this point receives a large amount of mine water from the coal operations nearby.

Portage, Cambria County, population 1,500, is a borough situated on the Little Conemaugh River near the mouth of Trout Run. There are a number of coal operations in and near the borough providing employment for practically all of the working population. There are eight of these mines in Trout Run valley operated by the following companies: Forge Mining Company, Irish Brothers Mining Company, George Pierce & Sons, Puritan Mining Company, Baker-Whitely Mining Company, Plymouth Mining Company, Princess Barno Mining Company, Last Chance Mining Company. Water is supplied to the public by the Martindale Water Company whose sources of supply are Trout Run at a point about four miles from the borough, whose watershed has about fifteen inhabitants and Farren

Run whose drainage area has a population of about seventy-five persons. Beside the public supplies, about a hundred individual wells are in use throughout the borough, many of which are liable to pollution from cesspools, and overflowing privy vaults. Cesspools and privies are generally used, in addition to which about fifteen private sewers discharge into Trout Run and eleven private sewers discharge to a spring run. The town has a few public sewers. Trout Run receives much mine drainage, but this is not true of Spring Run and the sewage discharged into the latter stream, therefore, creates more of a nuisance.

In August, 1911, the Commissioner of Health issued a permit for certain sewers to be built in Portage. In this permit the following discussion occurs.

"Modern sewerage facilities are needed in the borough of Portage. The local health board is handicapped in its efforts to maintain a sanitary condition in the town by the lack of adequate sewerage works. The installation of sewers on all streets will give the local authorities an opportunity to correct the existing nuisances. The proposed sewers are to be paid for by assessing the abutting property owners on the foot front plan.

"The Little Conemaugh River has its source near the borough of Cresson in the Allegheny Mountains seven miles northeast of Portage. From its headwaters it flows down through a narrow valley receiving along its course numerous tributaries which rise in the mountainous territory lying on both sides. The boroughs of Lilly and Cresson, in addition to a few mining towns are located along the course of the stream.

"Drainage from these towns is into the Little Conemaugh River, either directly or indirectly. In the boroughs of Cresson and Lilly sewer systems have been installed. At Portage considerable mine drainage enters the river from the mining operations in the vicinity and down stream six miles both domestic sewage and mine drainage are discharged into the river from the borough of South Fork and the village of Ehrenfeld.

"At Johnstown the Little Conemaugh River unites with Stony Creek to form the Conemaugh River which flows from this point in a general southwesterly direction to Saltsburg, where it unites with the Loyahanna Creek forming the Kiskiminetas River. On the Conemaugh River watershed are located a number of mine operations which turn into the streams a vast quantity of acid mine water.

"The Conemaugh River is first used for domestic purposes at Blairsville approximately forty-four miles below Portage. The supply passes through a distributing reservoir having a capacity less than the daily consumption. Nearly the entire population of the town use this water which receives no purification.

"Seventeen miles below Blairsville is the valley of Saltsburg where over one thousand people are served with river water daily. The raw water is raised to a distributing reservoir holding about thirteen days' supply.

"From Freeport down to the mouth of the Allegheny River, a distance of twenty-eight miles, the water of this stream is used to a very great extent by the municipalities located along its banks. The largest consumer of the Allegheny River is the city of Pittsburgh in which municipality a population of five hundred thousand is served with river water. The Pittsburgh city intake is down stream a distance of only one hundred miles.

"It is a general belief that the danger of obtaining a public water supply from the Conemaugh River without filtration of water is minimized because of the disinfection by acid mine drainage of sewage discharged into the river itself and its tributaries by the municipalities up stream. However, during times of freshets the effect of the acid in the streams may be so neutralized by the introduction of a large volume of storm water as to fail in destroying the sewage bacteria which may then be rapidly carried down stream and taken into the various water works systems through the intakes to the river. Because the purifying agencies at work cannot be controlled and regulated, it becomes a necessity in the interests of public health to exclude from streams, which are used as sources of public water supply, untreated sewage from the municipalities located on their drainage areas. If the Conemaugh River and other tributaries were not acid streams the probabilities are that the towns down stream using the river as a source of public water supply would have been visited by serious epidemics arising from water borne diseases.

"In order to protect the interests of the public health, it will be necessary eventually to exclude from the streams, which are a source of public water supply, untreated sewage. It is the intention of the State authorities to bring this about in the district in which Portage borough is located.

"The borough of Cresson has received a permit from the Commissioner of Health permitting sewer extensions to be made with the stipulations that the borough should prepare plans for the purifying of its sewage and submit same to the Commissioner of Health for approval. South Fork borough has made extensions to its sewerage system under conditions and stipulations provided by the Commissioner of Health, among others the borough was required to submit plans for a comprehensive sewerage system and sewage disposal works to said Commissioner for approval. Below South Fork, the boroughs of Scalp Level, Indiana, Blairsville, Saltsburg, and Derry have all been required to prepare plans for the purification of their sewages. The boroughs are all located in the Conemaugh River Basin. The boroughs of Derry and Indiana have already constructed and put in operation sewage disposal plants.

"The borough of Scalp Level was required to submit plans for a sewage disposal works on May first, nineteen hundred and eleven, and the borough of Blairsville is engaged in the preparation of plans leading to a discontinuance of the discharge of untreated sewage into the waters of the State.

"Plans for the disposal and collection of all sewage from the borough of Portage should be prepared and submitted to the Commissioner of Health for approval. A site for the location of a sewage purification works should be decided upon and the plans for the plant should be made. It is important now for the borough to adopt complete plans for sewerage and these plans must provide for an intercepting sewer from the two outlets to a sewage disposal plant or to a pumping station and disposal plant. The plans should also show the grades of all sewer lines, then after the plans are approved, modified or amended the borough may make extensions from time to time as the necessity demands.

"The assessed valuation of Portage is reported to be five hundred and ninety-six thousand, four hundred and fifty dollars and the bonded indebtedness about seven thousand dollars. If these figures be correct the borough can borrow in the neighborhood of thirty-five thousand dollars for public improvements before the legal indebtedness is exceeded. This amount is not sufficient to pay the cost of the complete sewer system for the borough and the construction of sewage disposal works."

Ebensburg, Cambria County, population 2,150, is a borough and the county seat situated in the central part of the county on a high level plateau between the head waters of the north branch of the Conemaugh River and of Black Lick Creek. The surrounding country is devoted largely to farming and the town is quite popular as a summer resort. There are no important industries in the borough except a small woolen mill and a grist mill with a water power installation on the north branch of the Little Conemaugh. The borough has a municipal water supply whose sources are mountain springs collected in two intakes, one on Black Lick Creek and the other on the Conemaugh watershed. The sources are free from pollution and the water is very generally taken, only about a dozen dug wells being used in the borough. The borough has an extensive combined system of sewers traversing nearly all of the streets and having a single outlet discharging into the north branch of the Conemaugh about a mile below the borough limits. Lake Rowena, a small pond and resort near the borough which furnishes the local ice supply, receives considerable pollution from a number of properties. Waste from the woolen mill is also discharged into the lake.

On the north branch of the Little Conemaugh River there is an impounding reservoir located about two miles northeast of Wilmore borough and within the boundaries of Summerhill township. The dam is 900 feet long and 35 feet high and was completed in 1908. It forms a lake two miles long holding over one billion gallons of water. The borough of Ebensburg is located at the upper end of this watershed which comprises about twenty-five square miles. A twenty-four inch pipe extends from the dam down the valley through

Wilmore borough to the Pennsylvania Railroad and then westerly along the railroad through Summerhill borough, Ehrenfeld village, and South Fork to East Conemaugh fourteen miles distant where it terminates in a distributing reservoir of 4,000,000 gallons capacity. The system is used by the Pennsylvania Railroad Company to furnish water to the railroad yards at South Fork and to large yards and shops in East Conemaugh borough. During the drought in 1908 the Conemaugh and Franklin Water Company was temporarily supplied from this twenty-four inch pipe line. The borough of Summerhill and the village of Ehrenfeld are supplied by the Cambria County Water Supply Company that has reserved rights to some of the water from the Wilmore dam. Hence the Commissioner of Health has required the borough of Ebensburg to prepare plans for the erection of a sewage treatment plant.

Wilmore, Cambria County, population 360, is a borough situated at the junction of the north and east branches of the Little Conemaugh River. It is a rural community in a rich coal region, but there are no mining operations in the immediate vicinity. There is no public water system but the Cambria County Water Supply Company has a franchise. About ten families derive their supply from springs, beside which there are five or six drilled wells and a large number of dug wells. There are no public sewers and only a few private sewers from individual properties. About six cesspools are in use, but the inhabitants generally use privies dug in gravelly soil. A small water power development exists here on Little Conemaugh River.

Summerhill, Cambria County, population 700, is a borough situated at the junction of Laurel Run and Little Conemaugh River. The inhabitants are largely employed in the neighboring mines, beside which the only industrial activities are a small planing mill and two slaughter houses. There is a small water power installation here on the Little Conemaugh. The public generally derive water for domestic uses from dug wells beside which there are a few drilled wells and springs in use. The Cambria County Water Supply Company serves perhaps twenty-five families with water derived from Laurel Run. The borough has three combined sewers, only one of which is extensive, being about 1,400 feet in length. Privies are universally used, some of them in compact shale and subject to frequent overflow, others in percolating gravelly soil and both types are frequently a menace to the numerous private dug wells scattered throughout the borough. One of the slaughter houses drains to a highway, and garbage and kitchen waste are discharged indiscriminately into the streets and on the banks of the streams. Many privies overflow into the streets and alleys and some of them overhang the banks of the Little Conemaugh and Laurel Run.

Ehrenfeld, Croyle Township, Cambria County, is a mining village with a population of 450 situated on the Little Conemaugh River just above South Fork. There is a small waterpower development at this point on the Little Conemaugh River. Water is supplied to the public in this village by the Cambria County Water Supply Company from Laurel Run above Summerhill borough. Practically the entire village directly or indirectly contributes sewage pollution.

St. Michael, Adams Township, Cambria County, is an unincorporated mining village on the South Fork of the Little Conemaugh River, population 300. It is a new settlement established by the Martland Coal Company for recently opened mines. The Flat Rock Water Company has constructed a system to supply water for domestic and industrial purposes to the inhabitants of the village and the Coal Company uses a branch of the South Fork known as Toppers Run. The watershed above the intake comprises about two square miles including perhaps ten farm properties and the small village of Salix with 150 population. Careful sanitary precautions, if exercised, should protect this supply and render it reasonably safe.

Below South Fork Creek, in the sub-basin of the Little Conemaugh River, are the boroughs of South Fork, East Conemaugh, and Franklin.

South Fork, Cambria County, population 4,500 is a borough situated in the south central part of Cambria County at the junction of the South Fork with the Little Conemaugh River some ten miles east of Johnstown. It is a coal mining town dependent largely upon the local operations of the Steinman Coal & Coke Company. The borough has a system of combined sewers aggregating some 11,000 feet and serving about one-fourth the population, discharging by way of two outlets into a ditch from which the sewage finds its way into the Little Conemaugh River above the junction of the South Fork. Conditions along this ditch would doubtless be offensive but for the fact that a coal mine discharges its acid drainage into the same channel. Nearly all of the inhabitants of the borough are supplied with water by the South Fork Water Company, a corporation deriving its supply from Sandy Run, Flenner's Run, and Croyle Run, the principal source being Sandy Run on which there is a 13,000,000 gallon impounding reservoir. The watersheds are wooded, but there are about twenty families residing thereon. A number of mines in and near the borough contribute a considerable quantity of acid mine drainage to the stream. The population not served by sewers use about forty cesspools and 634 privies.

During July of 1910 there was an outbreak of typhoid fever in South Fork due to a case of typhoid fever on the watershed of the local supply and in handling the local situation from a sanitary standpoint, it appeared to be essential to lay some additional sewers. These were permitted in a decree issued by the Commissioner of Health to the borough on August 4, 1910. The plans for a comprehensive sanitary sewer system and for sewage disposal works were acted upon in a decree issued in March 1912. In this decree the following statement was made:

"The consulting engineer has shown sufficiently in detail the salient outlines of the plans and since it is not contemplated to erect the works at once, it is his opinion that advancements in the art of treatment of sewage may develop which efficiency and economy will dictate should be incorporated in the designs at the time of the erection of the sewage disposal works. The plans show a thoroughly studied and well conceived layout and are adapted to such modifications as may be found desirable and there appears to be no good reason why the State should not approve of these general plans and in the future at the time it becomes necessary to erect the sewage works to then call for such further details and modifications of the layout as may be deemed necessary to assure efficiency and economy then."

East Conemaugh, Cambria County, population 4,050 is a borough situated on the north-side of the Little Conemaugh, opposite Franklin borough and about three miles above Johnstown. The inhabitants almost entirely are employed at the large plant of the Cambria Steel Company at Franklin across the river and on the Pennsylvania Railroad. Nearly half of the population obtain their water supply from dug and drilled wells and springs, the greater portion being served by the Conemaugh & Franklin Water Company. This company derives its supply from an impounding reservoir on Clapboard Run, a tributary entering the river at Franklin opposite East Conemaugh. The watershed has a resident population of 178 persons beside several hundred head of live stock. An outbreak of typhoid in Conemaugh and Franklin in August, 1907 resulted in an investigation by the Department which indicated that the probable source of the outbreak was a case of typhoid which occurred about the middle of July on the watershed above the reservoir. Since that time precautions have been taken by the water company to prevent pollutions. The borough has an extensive system of combined sewers discharging by way of a four foot brick sewer outlet and an open ditch into the river at the lower end of the town, the ditch also receiving the discharge from several small sewers. Privies are in general use, although a large number of these are reported to be connected with the sewer system. Kitchen waste, garbage, and some times sewage find their way to the highways and menace the purity of many of the wells and springs in use.

Franklin, Cambria County, population 1,500, is a borough situated on the south side of the Conemaugh River opposite the borough of East Conemaugh and adjoining the eastern boundary of the city of Johnstown. The sole industry of Franklin is a plant of

the Cambria Steel Company employing 4,000 men, mainly resident in Franklin, East Conemaugh, and Johnstown. Nearly half of the population is supplied by the Conemaugh & Franklin Water Company with surface water derived from Clapboard Run, which source has been described under the discussion of the borough of East Conemaugh. The remainder use water from dug and drilled wells and a number of springs, each well and spring serving a group of families. The borough has a system of combined sewers covering a large portion of the settled area with three outlets to Clapboard Run and three to the Little Conemaugh River. There are no cesspools and very few inside closets and about two-thirds of the privies are connected with the public sewers. Kitchen waste is largely discharged into the gutters and open ditches, while garbage is dumped near Silver Run at a point about half a mile above the borough line. The waste from the steel works is water carrying more or less oil but no acid.

In Table XLVI is given the list of typhoid cases reported by the local authorities of the towns in the Little Conemaugh River sub-basin to the State Department of Health for the years 1906-1912 inclusive.

TABLE XLVI.

Typhoid Fever Cases Reported for the Little Conemaugh River Sub-Basin, 1906-1912, inclusive.

Town.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
Cresson,	2	11	5	2	2	2	2
Portage,	0	0	2	0	7	13	0
Summerhill,	0	0	3	0	0	0	0
Ebensburg,	0	0	0	1	0	6	1
Lilly,	0	0	0	1	3	1	0
South Fork,	23	23	29	21	54	10	2
East Conemaugh,	0	0	40	6	1	8	2
Franklin,	2	28	4	3	9	5	3

In this sub-basin some of the suitable streams have been stocked by the State Fish Commission with trout and yellow perch.

The Cambria Steel Company has an intake dam on the Little Conemaugh River at South Fork. Samples of water here have been chemically analyzed by the company. The results are given in Table XLVII. The same company has also analyzed samples of water taken from the Little Conemaugh in Franklin Borough. The results appear in Table XLVIII.

TABLE XLVII.

Chemical Analyses of the Little Conemaugh River by the Cambria Steel Co.
(Parts per Million.)

	Little Conemaugh at South Fork, Pa.				Wooden Supply Line.			
	Sept. 16, 1904.	Nov. 5, 1904.	Nov. 19, 1904.	Nov. 20, 1904.	Jan. 14, 1905.	Jan. 23, 1905.	Jan. 23, 1905.	Jan. 23, 1905.
Iron and Alumina,	17.4	14.0	16.0	23.0	20.0	20.0	20.0	20.0
SO ₃ ,	137.2	280.9	222.6	203.6	244.0	244.0	244.0	244.0
Lime,	82.5	136.0	136.0	103.6	103.6	103.6	103.6	103.6
Magnesia,	27.4	26.9	19.6	40.2	25.9	25.9	25.9	25.9
Silica,	11.8	13.8	12.0	13.0	12.0	12.0	12.0	12.0
Free Acid,	49.6	23.6	19.2	35.2	7.6	7.6	7.6	7.6
Chlorine,	8.2	4.6	2.6	5.2	5.0	5.0	5.0	5.0
Total Solids,	356.0	475.4	483.4	523.0	431.7	431.7	431.7	431.7
	Dec. 3, 1904.	Feb. 24, 1905.	Mar. 11, 1905.	Feb. 11, 1905.	Apr. 24, 1905.	May 10, 1905.	May 10, 1905.	May 10, 1905.
Iron and Alumina,	10.6	27.8	258.8	20.2	12.4	12.4	12.4	12.4
SO ₃ ,	231.8	110.8	42.1	124.0	50.6	50.6	50.6	50.6
Lime,	78.0	94.7	17.7	43.4	21.6	21.6	21.6	21.6
Magnesia,	31.6	10.1	15.3	26.8	10.5	10.5	10.5	10.5
Silica,	18.2	16.6	362.0	10.8	8.4	8.4	8.4	8.4
Free Acid,	29.8	19.8	.....	19.0	.....	.....	.....	.....
Chlorine,	6.0	.....	.....	3.6	.....	.....	.....	.....
Total Solids,	378.8	237.4	881.6	253.0	140.2	140.2	140.2	140.2
	Mar. 26, 1905.	Apr. 10, 1905.	July 24, 1905.	May 24, 1905.	June 10, 1905.	June 21, 1905.	June 21, 1905.	June 21, 1905.
Iron and Alumina,	106.0	24.2	27.1	24.0	25.5	25.5	25.5	25.5
SO ₃ ,	38.4	55.0	69.5	69.6	32.7	32.7	32.7	32.7
Lime,	19.1	21.7	22.1	28.3	31.3	31.3	31.3	31.3
Magnesia,	16.6	24.2	11.0	14.1	16.1	16.1	16.1	16.1
Silica,	226.0	23.8	34.7	8.7	12.4	12.4	12.4	12.4
Free Acid,	1.9	8.2	40.0	6.6	10.0	10.0	10.0	10.0
Chlorine, .....	.....	.....	.....	.....	.....	.....	.....	.....
Total Solids,	473.5	191.4	180.7	194.6	271.4	271.4	271.4	271.4
	Sept. 25, 1905.	Mar. 17, 1906.	Apr. 12, 1907.	April 16, 1907.	July 6, 1908.	May 19, 1909.	May 19, 1909.	May 19, 1909.
Iron and Alumina,	26.0	11.0	23.9	20.4	18.0	22.4	22.4	22.4
SO ₃ ,	39.6	102.8	67.8	55.8	225.4	163.8	163.8	163.8
Lime,	80.0	32.9	29.6	18.4	75.6	44.5	44.5	44.5
Magnesia,	35.2	12.7	12.8	7.6	29.6	19.8	19.8	19.8
Silica,	21.4	18.9	4.8	33.2	20.8	6.8	6.8	6.8
Free Acid,	23.1	25.6	26.0	17.0	5.5	15.0	15.0	15.0
Chlorine, .....	.....	.....	.....	.....	27.0	27.0	27.0	27.0
Total Solids,	286.4	194.4	222.0	107.6	568.4	342.4	342.4	342.4

TABLE XLVIII.
Chemical Analyses of the Little Conemaugh River by the Cambria Steel Co.
(Parts per Million.)

Little Conemaugh, Franklin Borough.											
		June 27, 1898.	Oct. 22, 1899.	Feb. 6, 1904.	Feb. 8, 1904.	June 2, 1904.	Nov. 5, 1904.				
		9.2	5.3	14.6	14.6	14.6	9.0				
Iron and Alumina,	.....	79.8	109.0	52.0	52.0	52.0	113.0				
SO ₃,	.....	40.4	35.6	34.0	34.0	34.0	65.6				
Lime,	.....	10.5	8.7	8.7	8.7	8.7	17.7				
Magnesia,	.....	.....	.....	5.6	5.6	5.6	2.6				
Silica,	.....	.....	1.0	10.5	10.5	10.5	7.4				
Free Acid,	.....	1.0	.....	15.4	15.4	15.4	.....			
Organic Matter,	.....	.....	.....	.....	.....	.....	.....
Chlorine,	.....	209.0	.....	144.2	141.7	.....	3.2				
Total Solids,	.....	.....	.....	.....	.....	.....	205.8				
.....											
		Dec. 3, 1904.	Dec. 19, 1904.	Dec. 20, 1904.	Jan. 14, 1905.	Jan. 23, 1905.	Feb. 24, 1905.				
		13.2	10.8	12.2	12.0	6.4	18.2				
Iron and Alumina,	.....	133.8	137.1	126.6	103.2	54.3	98.2				
SO ₃,	.....	51.6	70.8	81.0	95.7	47.3	31.6				
Lime,	.....	20.0	16.1	25.1	24.6	12.0	9.8				
Magnesia,	.....	6.4	6.0	10.0	14.6	7.2	5.8				
Silica,	.....	11.1	.....	6.3	6.7	13.0	16.5				
Free Acid,	.....	.....	.....	.....	.....	.....	.....
Organic matter,	.....	6.4	5.2	2.4	4.0	1.9	3.1				
Chlorine,	.....	230.0	259.4	276.2	268.8	147.2	214.4				
Total Solids,	.....	.....	.....	.....	.....	.....	.....
.....											
		March 11, 1905.	April 10, 1905.	April 24, 1905.	May 10, 1905.	May 24, 1905.	June 10, 1905.				
		7.4	9.0	6.8	12.4	5.8	6.3				
Iron and Alumina,	.....	31.7	49.2	51.2	50.9	66.0	30.2				
SO ₃,	.....	13.9	18.6	19.7	22.1	29.8	13.1				
Lime,	.....	9.2	25.6	6.2	16.5	13.3	7.1				
Magnesia,	.....	9.2	4.6	5.0	11.6	7.0	2.6				
Silica,	.....	6.6	11.9	10.1	8.2	16.5	4.7				
Free Acid,	.....	.....	.....	.....	.....	.....	.....
Organic matter,	.....	.....	.....	.....	.....	.....	.....
Chlorine,	.....	85.4	111.8	103.2	121.8	161.4	95.4				
Total Solids,	.....	.....	.....	.....	.....	.....	.....
.....											
		June 26, 1905.	July 10, 1905.	Aug. 24, 1905.	Sept. 24, 1905.	Sept. 25, 1905.	.....			
		.....	14.2	19.0	28.6	28.6	.....			
Iron and Alumina,	.....	.....	63.6	68.4	90.8	90.8	.....			
SO ₃,	.....	.....	33.0	21.8	74.0	74.0	.....			
Lime,	.....	.....	9.8	27.6	35.4	35.4	.....			
Magnesia,	.....	.....	11.4	4.4	29.0	29.0	.....			
Silica,	.....	.....	10.0	11.5	19.8	19.8	.....			
Free Acid,	.....	19.4	.....	.....	.....	.....	.....
Organic Matter,	.....	.....	.....	.....	.....	.....	.....
Chlorine,	.....	4.2	.....	.....	.....	.....	.....
Total Solids,	.....	.....	187.9	130.0	283.4	283.4	.....			

In the Little Conemaugh River basin above Johnstown there is a total of ninety-six coal mines from twenty-two of which the drainage is pumped amounting to 10,075 gallons of mine drainage a minute. From the remaining seventy-four coal mines that have natural drainage there is a flow of 10,494 gallons a minute making a total quantity of mine water pollution in this sub-basin above Johnstown of 20,569 gallons a minute.

4. Survey of Stony Creek Sub-basin.

In the sub-basin of Stony Creek are the communities of Stoyestown, Hooversville, Jennertown, Jenner, Boswell, Benson, Windber, Paint, and Scalp Level.

Stoyestown, Somerset County, population 350, is a borough situated in the northern central part of the county on Stony Creek. It is an agricultural community with no industries in the borough although there are extensive coal operations in the vicinity. There are four small water power developments in or near Stoyestown; one on Beaver Dam Run, two on Stony Creek, and one at Kantner on Stony Creek developing 30 H. P. The inhabitants of the borough are largely dependent on individual wells and springs for their water supply; but a number of these sources have become polluted. The Stoyestown Water Company was incorporated in 1906, and on May 2nd, 1906 the Commissioner of Health issued a permit to this company to supply water to the public from two drilled wells. The borough has one public sewer and one private sewer, and on September 17th, 1906, the Commissioner of Health issued a permit for the construction of two other public sewers. The complete system will serve the greater portion of the population. Privies to the number of seventy have been in use and there are about fifty modern water closets, some of which have been discharging sewage into the street gutters. Kitchen wastes have been discharged either to abandoned wells or to the gutters. The borough's sewage reaches Beaver Dam Run just before it enters Stony Creek, and the former stream also receives acid drainage from coal mines.

In the permit of 1906, the Commissioner of Health had the following to say about sewerage:

"The borough can raise seven thousand dollars without exceeding the debt limit. The proposed sewers will cost half of this amount. If all possible connections were made on the basis of one hundred gallons per capita, the system would discharge thirty-two thousand five hundred gallons daily into the run. The run has a drainage area of about three hundred acres above the lower or Main Street sewer outlet. The dry weather flow of the stream is an inconsiderable amount. Owing to the steepness of the watershed, during rains, the bed of the run is thoroughly washed out. Below the Main Street sewer outlet proposed, the slope of the run is about one hundred and fifty feet in fifteen hundred feet, having its course through pasture land and timber land to Beaver Dam Run. Cattle drink the water. The discharge of sewage into it will increase the pollution and render the water unsuitable as a pasturage stream.

"Beaver Dam Run is an acid stream to some extent, because it receives drainage from at least one coal mine. Probably the acidity of this stream will increase, and as coal is mined from the bank here, this acidity may be considered permanent. The cost of extending the present public sewer outlet down the valley of Maurers

Run to the proposed Main Street outlet, and from this junction continuing down the valley to Beaver Dam Run, a total distance of about twenty-five hundred feet, plus the cost of the proposed sewers, is well within the amount of money which the borough can borrow. Permission to discharge sewage from this main interceptor into Beaver Dam Run would obviate suits for damages which very probably would be brought by the proprietors whose cattle are pastured in the fields bordering Maurers Run, and it does not appear that a temporary discharge at this point would be detrimental to the interests of the public health. So far as the Department of Health knows, there are no places between Stoyestown and the city of Johnstown which take water for drinking purposes from the stream. The sewage of this city is discharged into the river, as is also true of places below Johnstown. The waters are very acid and dirty and cannot be suitable for domestic purposes without placing prohibitions on the industries in the territory which prohibitions are not known to be practical at this time, although they may be in the near future.

"Beaver Dam Run at its junction with Maurers Run has a drainage area of twenty-five square miles so that the dry weather flow is sufficient to prevent a nuisance. About one thousand feet below this junction Beaver Dam Run enters Stony Creek which has a drainage area at this point of approximately one hundred and ten square miles. For these reasons and the fact that the borough cannot raise money enough to build a properly designed sewage treatment plant at this time, and because sewers are needed in the borough and Maurers Run should be preserved as a pure stream, it is unanimously agreed that the interests of the public health demand that temporary permission be granted the borough to discharge its sewage into Beaver Dam Run, and that a public sewer be built in Main Street and in South Alley as proposed under the following conditions."

Hooversville, Somerset County, population 950, is a borough situated on Stony Creek about five miles below Stoyestown. It is a mining town with important operations in and near the borough belonging to the Federal Coal Company, the Knickerbocker Smokeless Coal Company, and the Somerset Mining Company. There is no public water system, the inhabitants deriving their supply from drilled and dug wells and springs. The Hooversville Water Company is now erecting a water works system with a supply from Fallen Timber Run by way of a new storage reservoir. There are two public sewers, one for surface water only, the other a combined sewer with sanitary connections, both discharging into Stony Creek, beside which there are a number of private sewers with outlets to Stony Creek, Fallen Timber Run, and Dixie Run. Nearly all of the houses have privies and a few have cesspools for kitchen waste, but waste water from the houses is largely discharged to the highways or streams and a number of the privies overhang the creek or runs. The mines discharge considerable acid water into the stream.

Jennertown, Somerset County, population about 100, is a rural community in the northwestern part of the county on Hays or Pickings Run near its junction with Quemahoning Creek, a tributary of Stony Creek. The borough has no industries. Water for domestic use is derived entirely from drilled and dug wells, there being no public water system. As there are no sanitary sewers, the population depend upon privies, which, however, are well kept and there is consequently, very little pollution of the stream at this point.

Jenner, Jenner Township, Somerset County, population about 800, is a village almost entirely owned by the Somerset Coal Company, 500 employees, which has mining operations near by. It is situated on Quemahoning Creek about a mile and a half east of Jennertown Borough. Water for domestic purposes is obtained

from three springs and one drilled well. For industrial purposes the Somerset Coal Company derives a supply from Quemahoning Creek, which is pumped to two tanks with a capacity of 100,000 gallons. There is one sewer with five connections discharging into Quemahoning Creek and a number of open ditches receive kitchen waste. The privies, which are in general use, are dug in soil of a percolating nature, but one overflows to a highway.

Boswell, Somerset County, population 1,200, is a borough situated on Quemahoning Creek about nine miles and a half from its confluence with Stony Creek and about three miles east of Jennertown borough. It is a mining town dependent entirely upon the operations of the Merchants Coal Company which owns much of the borough property. This company also operates a public water supply system under the name of the Jenner Water Company whose supply is derived from a 300 foot drilled well. Only a portion of the public is served, the remainder getting water from other wells. There is an extensive sewer system built and owned by the Boswell Land Improvement Company with a twenty-four inch outlet to Quemahoning Creek by way of a railroad culvert. Several other private sewers discharge directly or indirectly through the same culvert; one of them a ten inch sewer belonging to the Merchants Coal Company discharges into a street gutter and thence by open ditch some distance to the culvert. Comparatively few houses have sewer connection, privies being commonly used. Street gutters and open ditches receive kitchen waste generally and in many cases an overflow from privies.

Benson, Somerset County (Hollsopple P. O.), population 500, is a borough situated in the northern part of the county on Stony Creek. It is a mining town with operations near by of the Hawes Coal Company with about 100 employees and the Althous Coal Company employing about fifty persons, beside which there are the Johnstown Vehicle Manufacturing Company with about eight employees, a planing mill, and a slaughter house. Water for domestic use is derived partly from a number of springs but largely from dug wells, there being no public water supply system. The borough has no public sewers, but there are a few private sewers discharging into an old mill race or to the creek. Privies are in use, in some instances overhanging the mill race or creek or discharging on the banks thereof.

Windber, Somerset County, population 5,000 or more, is a borough situated on Paint Creek near the Cambria County boundary. Adjoining Windber on the northwest is the borough of Paint, Somerset County, and beyond that the borough of Scalp Level, Cambria County. These three towns are practically one community. Windber is industrially dependent upon the Berwind-White Coal Company, whose operations in its immediate vicinity are very extensive.

There are also several small industries including a brick yard, and a planing mill. Aside from about twelve private wells the inhabitants obtain water from the Paint Township Water Company which is subsidiary to the Windber Water & Power Company. The water supplied to Windber and to the borough of Paint is derived from two dams on Big Paint Creek having seventeen square miles of wooded and practically uninhabited watershed. The borough has a general system of combined sewers which are said to be inadequate in size in some instances. A large number of privies are connected therewith, but others frequently overflow into the highways which also receive much kitchen waste. The coal workings discharge great quantities of acid drainage into Paint Creek in and near the borough.

Paint, Somerset County, population 600, is a borough adjoining the northern or Cambria County boundary and adjacent to the borough of Windber on the southeast and Scalp Level, Cambria County, on the north. It is situated on Paint Creek just below Windber. It is dependent in part upon the operations of the Berwind-White Coal Company which has a mine within the borough limits. The Paint Township Water Company, subsidiary to the Windber Water & Power Company supplies the public with water from a wooded watershed on Paint Creek, this supply also being furnished to the borough of Windber. Beside this supply there are about five private wells in use. There are a number of private sewers and practically all of the population contribute sewage pollution.

Scalp Level, Cambria County, population about 1000, is situated on the southern boundary of Cambria County on Little Paint Creek at its junction with Paint Creek and just below the boroughs of Paint and Windber which places are on the latter stream. It was formerly a farming village but it is now a thriving town dependent largely upon coal mining operations of the Berwind-White Coal Company. Water is supplied to the public by the Richland Township Water Co. operated by the Windber Water & Power Company the supply being obtained from a point on Little Paint Creek about two miles above the borough. The watershed above the intake contains several coal mining operations and the village of Elton with a population of about 250. In addition to this supply there are in use seven or more private dug wells. There are between fifteen and twenty private drains to the creek and one public sewer has been constructed in accordance with a permit issued by the Commissioner of Health. Both Paint Creek and Little Paint Creek are heavily charged with acid water from coal mines. In a permit of May 18th, 1908, the Commissioner of Health had the following to say about sewerage.

"The sewers now proposed and under consideration will serve that portion of the old village above described. A sixteen inch main sewer is to start at Little Paint Creek and extend up the turnpike a distance of 900 feet to or near the angle in the

turnpike. One hundred and fifty feet from the end a twelve-inch branch sewer is to be laid in a branch road westerly a distance of 750 feet, passing the school house for which sewerage facilities are demanded. The least grade for the sewers is 3.4 per cent. and the greatest 9.25 per cent.

"The main creek is about 760 feet down stream from the proposed outlet where, at one time, it was contemplated the sewer would terminate. Owing to the very limited financial resources, the local authorities do not want to make any greater expenditure than may be necessary; hence approval of the outlet into the tributary stream where the turnpike crosses is asked. Presumably the discharge of sewage would be of such small volume for the present that no nuisance will be created at the outlet. There are shoals on either bank of the stream at the bridge. The bed of the creek is steep and the flow of water rapid. Any small pool could easily be drained.

"There is one means of saving money which has escaped the borough. An eight inch pipe on the grades proposed would be many times greater in capacity than actually necessary to remove sewage from the proposed district. The local authorities can with perfect safety save the cost between an eight-inch sewer and a twelve and sixteen-inch sewer.

"There are periods of several weeks duration in the year when the run-off from the upland watersheds is so great that the germicidal effect of the acid water is probably neutralized, and at such times the sewage from the mining town may reach the water works intakes of the down stream towns. The waters of the region are discharged by the Conemaugh River into the Kiskiminetas River, and through the latter into the Allegheny River opposite Freeport. This place takes its water from the river and below Freeport, in a distance of twenty-three miles, there are nine other places which take the public water supply from the Allegheny. Twenty miles and thirty-six miles, respectively, below Johnstown the boroughs of Blairsville and Saltsburg obtain their public supply from the river. The sewage of Johnstown is now discharged into the Conemaugh and is a menace because it may be transmitted down the river and be introduced into the homes of water consumers. Because an epidemic has not occurred from this cause is not a guarantee that it may not happen. The danger exists. It is probable that, within the period for which it is economical to design sewers, a change in the methods of disposal of sewage in its raw state in the streams, may be brought about in the Conemaugh River Basin.

"Scalp Level borough is amply able to defray the cost of the preparation of a sewerage plan, either independently or in conjunction with the boroughs of Paint and Windber."

In a permit of May 28th, 1908 in a further discussion of the sewerage situation of Scalp Level the following statements were made by the Commissioner of Health.

"The new outlet is an obscure place away from dwellings. The plan is to excavate a trench in the bottom of the channel and to imbed the sixteen-inch sewer in a cradle of concrete and to cover it over with the same material. This form of construction is expensive and unless it be executed with great care it will not be durable. The creek is a mountain stream subject to tremendous freshet flows and scouring currents. In the said permit of May eighteenth, the borough's attention was especially called to the safety and economy of reducing the size of the main sewer. The wisdom of a reduction in size is now more apparent than ever if the proposed plan to lay a sewer down the creek bed be carried out. The land on the north bank rises precipitously and there is no opportunity favorable for the building of a sewer in this bank from the turnpike down stream when such sewer must be begun at a level at the turnpike deep enough to drain the cellars along the highway. The petitioners represent that they have given careful consideration to the project of avoiding the construction of a sewer in the creek bed with the conclusion that there is no other location. An eight-inch sewer should be large enough for all requirements, and certain it is that a ten-inch pipe would never have its capacity taxed and since the cost of the laying of a ten-inch pipe in the bed of the creek would be very much less than the cost of laying a sixteen-inch pipe, this change in the plan ought to be adopted by the borough. Furthermore, it has been proven by experience that for small pipes it is cheaper and better where they must be laid in the bed of a mountain stream to use cast iron pipe instead of clay pipe. All things considered, it is cheaper and better to adopt this form of construction.

"The petitioners further represent that there is a fall in the bed of the creek where it is proposed to terminate the sewer so that the outlet will be elevated many feet above the valley of Big Paint Creek in which a trunk sewer for the adjoining boroughs of Paint and Windber may be laid and into which it may be desirable and easily possible at some future date for the proposed Scalp Level sewer to empty."

The Fish Commission has stocked some of the suitable streams in the sub-basin of Stony Creek with trout.

On Stony Creek the Cambria Steel Company maintains an intake dam from which water is derived for industrial purposes. This company has chemically analyzed Stony Creek waters and in Table XLIX the results are given:

TABLE XLIX.
Chemical Analyses of Stony Creek by the Cambria Steel Company.
Parts per Million.

	Oct. 22, 1899.	April 6, 1904.	July 28, 1904.	Nov. 19, 1904.	Dec. 3, 1904.	Dec. 21, 1904.	Jan. 14, 1905.
Iron and alumina,	Trace.	1.0	7.6	2.4	7.0	9.0	7.5
SO ₃ ,	55.6	5.6	12.4	22.3	25.9	46.4	28.2
Lime,	47.2	2.0	23.6	28.2	31.8	34.8	30.6
Magnesia,	24.2	Trace.	9.4	9.4	7.2	10.9	7.5
Silica,			4.6	3.4	20.2	17.2	21.1
Free Acid,			14.8				None.
Chlorine,			4.0	2.8	5.2	4.6	3.6
Total Solids,		8.9	69.6	91.6	107.0	118.2	116.9

	Jan. 24, 1905.	Feb. 13, 1905.	Feb. 24, 1905.	Mar. 24, 1905.	Apr. 19, 1905.	Apr. 24, 1905.
Iron and alumina,	4.2	4.0	4.8	12.4	51.8	4.8
SO ₃ ,	17.8	27.0	31.4	18.2	16.8	23.0
Lime,	20.2	12.4	11.3	8.5	10.5	12.3
Magnesia,	6.0	21.6	9.4	8.9	17.8	3.6
Silica,	10.2	6.5	7.0	10.6	87.8	5.8
Free Acid,	None.	None.	None.	1.8	None.	None.
Chlorine,	1.1	1.3				
Total Solids,	65.0	75.6	72.0	56.2	201.2	61.0

	May 24, 1905.	June 10, 1905.	June 24, 1905.	July 24, 1905.	Aug. 24, 1905.	Sept. 29, 1909.
Iron and alumina,	4.5	20.0	4.1	11.6	23.4	29.0
SO ₃ ,	13.4	17.9	20.6	14.3	21.6	90.0
Lime,	7.4	9.8	14.2	9.2	18.8	38.0
Magnesia,	2.0	8.1	7.2	4.9	26.6	14.4
Silica,	2.2	100.0	20.4	31.9	38.0	22.0
Free Acid,	None.	None.	1.0	None.	3.3	9.0
Organic Matter,						19.4
Total Solids,	51.8	199.2	82.8	86.6	154.0	205.4
MgSO ₄ ,						43.2
CaSO ₄ ,						92.3

In the Stony Creek sub-basin there are eighty coal mines. From eighteen of these the mine drainage is pumped amounting to 10,445 gallons a minute. From the remaining sixty-two mines the drainage flows by gravity amounting to 14,320 gallons making a total of 24,765 gallons a minute being discharged into the waters of the State in the Stony Creek sub-basin.

In the first part of the year 1908 there was a typhoid fever epidemic at Boswell. In Table L are given the typhoid fever cases that have been reported by the local authorities of the towns in the Stony Creek sub-basin to the Department of Health for the years 1906 to 1912 inclusive.

TABLE L.

Typhoid Fever Cases Reported for the Stony Creek Sub-Basin, 1906—1912, inclusive.

Town.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
Scalp Level,	0	0	5	0	0	1	0
Stoyestown,	0	1	0	0	0	0	0
Boswell,	0	0	119	12	9	3	3
Windber,	0	0	0	6	0	0	0
Benson,	0	0	0	0	7	0	0
Hooversville,	0	0	0	0	0	0	1

5.—Survey of Black Lick Creek Sub-basin.

In the sub-basin of Black Lick Creek are the following communities: Nant-y-Glo, Big Bend, Twin Rocks, Vintondale, Wehrum, Armagh, Mechanicsburg, Josephine, Indiana, Homer City, Graceton, and Coral.

Nant-y-Glo, Cambria County, population 1,400, is an unincorporated village on Black Lick Creek about seven miles below and east of its head waters near Ebensburg. It is a coal mining town with five principal operating companies: the Nant-y-Glo Coal Company with ninety employees producing from 300 to 400 tons daily, the Pennsylvania, Beech Creek and Eastern Coal Company producing 500 or more tons daily, the Ivy Hill Coal Company with 90 employees producing 300 tons daily, and near the village the Lincoln Coal Company producing probably 300 tons and a new, large mine of the Springfield Coal and Coke Company. About a mile up-stream from the village is a small chemical plant for the manufacture of wood alcohol. Black Lick Creek divides the town into two parts. In the portion northwest of the creek, water is piped to six families from a spring and small reservoir reasonably well protected, and to four families from another spring. Twenty-four families derive water from four running spouts piped from a third spring. The three springs are reasonable free from chance pollution. On the southwest side of the creek the inhabitants get their supply from fifteen wells, several of which are dug, and from five or more open springs which in some cases are subject to considerable surface pollution. On August 15th, 1908, a permit was issued by the Commissioner of Health to the Nant-y-Glo Water Company, not a corporation, to supply the public in Nant-y-Glo village with water for domestic purposes and fire protection deriving its supply from Davis Run, with an uninhabited watershed. The Pennsylvania, Beech Creek and Eastern Coal Company derive a boiler supply from Schuman Run near the village. The Nant-y-Glo Coal Company use the less sulphurous mine drainage in their boilers. There is no sewer system but there are a few private sewers to Black Lick Creek. Every house has a privy and as the soil is hardpan, many of the vaults overflow to alleys, yards,

and highways. A slaughter house projecting over the stream discharges wastes which at times are extremely offensive. The mines in this vicinity discharge large quantities of acid drainage into the creek. The chemical works above the village pollutes the stream to a considerable extent.

Big Bend (or Expedit) Cambria County, population 700, is a mining village in Black Lick Township near the western part of the boundary of the county on the south branch of Black Lick Creek. It is a mining town dependent almost entirely upon the operations of the Commercial Coal Company with about 325 employees, and the Big Bend Coal Company with about 200 employees. Water is supplied to the public by the Marie Water Company, a corporation deriving its supply from an impounding reservoir on Spring Run north of the village. The watershed above the reservoir is uninhabited partly wooded and about one and a half square miles in area. This supply has recently been augmented by the construction of the Seldersville Reservoir with a capacity of 25,000 gallons, which is supplied by springs immediately above it and the surface drainage from about twenty acres. This area contains a dwelling occupied by two persons. The Department has under consideration an application filed by the company for permission to use this additional supply. The water company supplies practically all of the inhabitants of the village. There are four individual private sewers discharging into Coalpit Run, but no public sewer system. Privies are in general use, principally dug in rock and provided with overflows. Both the run and the creek are polluted by kitchen wastes disposed of upon the surface of the ground and in gutters and by overflowing privies, the drainage from which produces extremely unsanitary conditions. It is estimated that probably 5,000,000 gallons of mine drainage are discharged daily into the creek from the several mines around Big Bend and the creek is also greatly polluted by mine drainage from several points above.

Twin Rocks, Cambria County, population 350, is a mining town practically a continuation of the village of Big Bend described above. Water is obtained generally from two springs, one of which is liable to contamination from surface drainage. There are no sewers nor cesspools and the general discharge of kitchen waste, and garbage and the overflow from privy vaults to the ground and streets produce an unsanitary condition and a pollution of the stream.

Vintondale, Cambria County, population 1,800, is a borough situated at the junction of the north and south branches of Black Lick Creek near the western boundary of the county. It is a mining town dependent almost exclusively upon the operations of the Vinton Colliery Company with mines and 150 coke ovens giving employment to about 900 persons. Water is supplied to nearly all the inhabitants by the Jackson Water Company, whose sources of supply are Bracken

Run and Schuman Run, small streams with about fifteen persons resident on the watersheds. In times of extreme drouth this supply is augmented by the use of water from the north branch of Black Lick Creek obtained through the Black Lick Water Company. The latter company pumps about 500,000 gallons of water daily for industrial purposes, at the colliery and coke ovens and for washing all of the coal that is used for coking. A few dug wells and a spring are used to some extent for drinking purposes, the latter being liable to pollution. About a dozen families have inside closets and private sewers to the creek, but privies are in general use and the soil being hardpan there is considerable overflow resulting in extensive pollution to the ground, highways, and creek.

Wehrum, Indiana County, population 900, is an unincorporated village situated on Black Lick Creek in Buffington Township near the eastern boundary of the county. Industrially the town is dependent upon the Lackawanna Coal and Coke Company, employing about 375 men. Water is supplied to the public by the Buffington Water Company and is derived from Rummels Run, a rapid, mountain stream with a population of about eighty resident on the watershed. The entire population is served by this company. There is one twenty-four inch sewer with about ten connections discharging into Black Lick Creek, this being the only sewer in the village. Privies are in general use, in several cases overflowing, and kitchen waste to some extent is sewered to the highways. One alley in particular receives overflow from privies and kitchen waste and is used as a general dumping ground for refuse.

Armagh, Indiana County, population 130, is a small, rural borough situated on the divide between Black Lick Creek, and the Conemaugh River about two miles from the former and three miles from the latter. The Kiskiminetas Coal Company has operations some two miles from the borough. There is no public water system, the inhabitants deriving their supply from dug wells. There are no sewers and the privies which are universally used are in percolating soil. Kitchen waste to some extent reaches Mardi's Run, a tributary of Black Lick Creek, which also receives the natural drainage of the town.

Mechanicsburg (Brush Valley P. O.) Indiana County, population 150, a small rural borough with no industrial plants, is an inland town near the head waters of Brush Creek, a tributary of Black Lick Creek. The borough is without a public water system, the inhabitants deriving their supply from individual dug wells and three drilled wells. There are no sewers and privies are used universally, generally kept in fair condition. A few properties drain kitchen waste to the highways.

Josephine, Burrell Township, Indiana County, population about 1,000, is an industrial village recently built in connection with the

extensive blast furnaces of the Josephine Furnace and Coke Company on Black Lick Creek about one mile east of its junction with Two Lick Creek. There are two water companies, both controlled by the Furnace Company interests. The Josephine Water Company, which supplies water for domestic purposes throughout the town derives its supply from drilled wells, only one of which is in use, the several remaining wells being available for future demands. The Furnace Water Company supplies water to the Furnace Company for boiler purposes from another one of these wells and for cooling purposes from an intake in Black Lick Creek just above an eight-foot concrete dam. The Furnace Water Company supplies water only for industrial purposes and there is reported to be no connection between the systems of the two companies. About fifteen houses on the west side of the creek opposite the main part of the village have shallow privy vaults, but aside from these and the office buildings of the company which have six-inch sewers to Black Lick Creek, the houses are all connected with an extensive sewerage system having a single outlet thirty inches in diameter discharging into Black Lick Creek just below the village.

Indiana, Indiana County, population about 7,000, is a borough and the county seat, and is situated near the head waters of Stony Run, a small branch of Two Lick Creek, the latter being one of the principal tributaries of Black Lick Creek. The town has a few industries, including the Dugan Glass Company's plant employing about 200 hands, two foundries, two grist mills, a car factory, woolen mills, and a tannery, but it is mainly dependent on extensive soft coal operations in the vicinity. The rich coal deposits in this neighborhood are being developed on a large scale and a recent rapid increase in population is likely to continue. About two-thirds of the population are supplied with water by the Clymer Water Company which derives its supply from Two Lick Creek at a point about three miles above Burrell. The drainage area above the intake is about seventy-eight square miles and contains several mining settlements, including the village of Clymer, with a population of about 3,000 persons. On May 28th, 1907, the Commissioner of Health issued a permit to the Clymer Water Company to extend and improve its water works system by the construction of a filter plant, reservoir, etc., under certain conditions and stipulations. The filter plant was constructed, but all the conditions of the permit were not carried out and the operation of the plant, in consequence, has as yet not been highly successful. Private wells and springs throughout the borough supply the remaining third of the population with water for domestic purposes. While there are both public and private sewers in the town, privies abound and there are some cesspools. The public sewers are built in accordance with a comprehensive plan to receive sewage and roof water together with some cellar drainage and

are all connected with and discharge through a single eighteen inch outlet to a sewage disposal plant on the bank of Stony Run. About seven miles and a half of sewers are connected with this system. White Spring Run and March Run, both tributary to Stony Run, are largely polluted by the sewage discharge from private outlets and the manufactural wastes, especially from the brewery, woolen mill, and tannery. In view of the former extensive pollution of Stony Run and particularly the local nuisances caused thereby, the Commissioner of Health on June 10th, 1907, issued a decree requiring the preparation of revised sewerage plans and plans for the treatment of the borough sewage, suggesting that the borough authorities provide compulsory connection with the public sewer system. On September 3rd, 1907, a special permit was granted for a single sewer extension, pending the submittal of the plans previously called for and on May 28th, 1908, the Commissioner of Health issued a permit approving proposed sewerage plans and sewage disposal works. The brewery, woolen mill and tannery wastes are sufficiently extensive to create a decided local nuisance in Stony Run independent of the sewage pollution which has heretofore existed. The sewage disposal works consisting of settling tanks, sprinkling filters and chemical disinfection of effluent for the borough of Indiana, were constructed and started in operation by May, 1911, and at the close of the year 1912, substantially the entire sewage of the borough was being treated at the plant.

Homer City, Indiana County, population 1,200, is a borough situated at the junction of Two Lick and Yellow Creeks about three miles above the confluence of Two Lick and Black Lick Creeks. Its industries include the Prairie State Incubator Company, employing eighty persons, the Guthrie Tuck Manufacturing Company's planing mill with eight men, and the Nix Gas Engine Company. There are also large coal operations near by. There is no public water system, the inhabitants obtaining water from drilled and dug wells and springs. There is no sewerage system, nearly every house having a privy. A large number of properties discharge kitchen waste into the highways. The Prairie State Incubator Company's plant has a six-inch sewer discharging sewage from the plant into Yellow Creek.

Graceton, Indiana County, population 700, is situated on Two Lick Creek above and adjoining Coral village which in turn is just above the junction of Two Lick and Black Lick Creeks. It is a village dependent upon the operations of the Graceton Coke Company which has mines and 202 coke ovens. The coal used for coking is all washed. The Graceton Coke Company has a private water supply system serving their plant and supplying the public with water for domestic purposes. Water is derived for domestic and to some extent for industrial uses from mountain springs, but the supply is

inadequate and is reinforced by pumping from Two Lick Creek. In addition to this supply there are eight drilled wells. There are two private sewers in the town, one four inches in diameter and serving the store and office building of the company, the other ten inches in diameter and serving four residences, both sewers discharging into a small run. Each house has a privy said to be cleaned out annually, but in many cases frequently overflowing. Garbage and kitchen waste are discharged indiscriminately into the highways. About 8,000,000 gallons of water daily are used at the washery in preparing coal for coking and a large amount of coal in suspension is thus carried into the stream.

Coral, Indiana County, population 500, is a village situated on Two Lick Creek just below the village of Graceton and just above the junction of Two Lick and Black Lick Creeks. The town is industrially dependent entirely upon the operations of the Joseph Wharton Coal and Coke Company, operating a large mine and about 300 coke ovens. Water for domestic purposes is obtained from drilled wells about sixty feet deep. The company has a private supply for industrial purposes derived from mountain springs with three reservoirs, total capacity 43,000,000 gallons, located on high ground above the village. An auxiliary supply is obtained from Tulip Creek and large quantities of water are used from this source for washing the coal in preparation for coking. There is no sewerage system and but one private sewer. This serves the company's office and store. Outside privies are in general use, in many cases overflowing and the highways receive much kitchen wastes and garbage.

The Fish Commission has stocked a number of suitable streams in Indiana County within the Black Lick Creek sub-basin with trout, bass, yellow perch, and pickerel. The Josephine Furnace and Coke Company has analyzed Black Lick Creek water at Josephine and also the driven well water. In Table LI the results are given.

TABLE LI.

Analyses of Black Lick Creek Water and of Well Water at Josephine by the Josephine Furnace & Coke Company.
Grains per U. S. Gallon.

Determination.	Black Lick Creek Water.		Drilled Well Water.	
	Sept. 23, 1908.	Jan. 26, 1909.	Sept. 22, 1908.	Aug. 4, 1909.
Silica, .....	.52	.52	.93	.42
Oxide of Iron and Alumina,	1.63	.47	1.34	.29
Calcium Sulphate,	9.77	1.85	1.33	6.16
Magnesium Sulphate,	3.99	1.73	.....	.....
Magnesium Chloride,	1.54	.46	.....	.....
Sodium Chloride, .....	.61	.....	.86	.76
Volatile and Organic Matter,	1.17	.35	.47	.....
Total Solids,	19.23	5.49	13.75	11.65
Free Sulphuric Acid,	3.01	None.	.....	.....
Magnesium Carbonate, .....	.....	.17	1.98	2.41
Calcium Carbonate, .....	.....	.....	3.91	1.62
Sodium Sulphate, .....	.....	.....	3.03	.....

There are sixty-eight coal mines in the Black Lick Creek sub-basin. Of these seventeen have the mine drainage pumped which amounts to 6,465 gallons a minute. The remaining fifty-one mines drain by gravity discharging 7,885 gallons a minute making a total of 14,350 gallons a minute of mine drainage that reaches the waters of the State in this sub-basin. In Table LII are given the typhoid fever cases reported by the local authorities of the boroughs in the Black Lick Creek sub-basin to the State Department of Health for the years 1906 to 1912 inclusive.

TABLE LII.

Typhoid Fever Cases Reported for the Black Lick Creek Sub-Basin, 1906—1912, inclusive.

Town.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
Vintondale,	0	0	9	3	2	1	10
Nant-y-Glo,	12	10	0	0	0	0	0
Homer City,	3	0	3	0	4	2	1
Indiana,	0	0	5	0	7	5	6
Clymer,	0	0	0	0	1	3	4
Mechanicsburg,	6	0	0	0	0	0	1

6.—Survey of Loyalhanna Creek Sub-Basin.

In the Loyalhanna Creek Sub-Basin there are the communities of Ligonier, Donegal, Youngstown, Latrobe, and New Alexandria.

Ligonier, Westmoreland County, population 2,500, is a borough situated in the upper part of the Loyalhanna Creek watershed at the junction of Mill and Loyalhanna Creeks. There are no manufacturing of importance, the village being formerly a lumbering town, but of late years a farming community and much frequented as a summer resort. A sanatorium is located in the centre of the borough. The town has a municipal water supply derived from Furnace Run, a clear mountain stream forming one of the headwaters of Loyalhanna Creek, and about three-quarters of the population are served with this water, the consumption being estimated at 60,000 gallons a day. Privies abound in the borough and there are a few cesspools. Sink and wash water is usually emptied into street gutters and alleys. On July 3rd, 1906, the Commissioner of Health issued a permit to the borough for the construction of a sanitary system of sewers and requiring the erection of a sewage disposal plant for the purification of the borough's sewage. Some sewers have since this been constructed. The stream at this point is heavily polluted with sewage from Ligonier and many mining settlements above the borough, especially on Mill Creek where there are a large number of mines and coke ovens.

Donegal, Westmoreland County, population 160, is a borough situated in the southeastern part of Westmoreland County on the di-

vide between the Allegheny and Monongahela watersheds, a part of its drainage reaching the Allegheny by way of Four Mile Run, one of the principal tributaries of Loyalhanna Creek, and a portion flowing into the Youghiogheny River by way of Indian Creek. It is a rural community without industries except that a number of inhabitants are employed in saw mills in the nearby mountains. There is no public water supply, the people depending upon individual sources, including twenty-five dug wells, one drilled well and eight springs. There are no sewers and the privies which are universally used appear to be well cared for.

Youngstown, Westmoreland County, population about 550, is a small borough situated on Nine Mile Run about one mile from its point of discharge into Loyalhanna Creek, just above Latrobe. It is a rural community without industries, but there are extensive coal and coke operations in the surrounding territory, especially above the town on Nine Mile Run. The borough has no water system and the inhabitants depend upon drilled and dug wells. There are no public sewers and but two or three private sewers from individual properties, beside a few drains for sink water discharging into the highways or runs. Among the more important coke operations on Nine Mile Run are 400 ovens of the H. C. Frick Coke Company at the village of Baggaley and 355 ovens of the Hostetter-Connellsville Coke Company at Hostetter village. In consequence of these extensive operations, Nine Mile Run contributes to Loyalhanna Creek large quantities of acid mine water.

Latrobe, Westmoreland County, population about 10,000, is a borough situated near the central part of the county on Loyalhanna Creek. It is the centre of what is known as the Latrobe coke field and the mining and coking of coal is carried on to an enormous extent in its immediate vicinity, this forming the dominant industry of the region. Aside from these operations the principal industrial plant in the borough is the Latrobe Tire Department of the Railway Steel Spring Company, giving employment to about 1,000 persons. Other industries in or near the borough are the Pierce Manufacturing Company's woolen mills, employing about 140, the Mississippi Glass Company, the Peters Paper Company, the West Latrobe Foundry and Machine Company with about 50 employees, and two large brick yards, that of the Latrobe Brick Company giving employment to about thirty persons. There are also six slaughter houses in the borough. Water is furnished to the entire community by the Latrobe Water Company, a corporation deriving its supply from Loyalhanna Creek at Kingston, a short distance above Latrobe. The consumption is 3,000,000 gallons a day, half of which is used for industrial purposes, the company having 1,800 domestic service taps and seven industrial taps. The watershed above the company's in-

take is fifty square miles in extent with a large rural and industrial population including Donegal and Ligonier Boroughs and a great number of collieries and coke ovens especially on Mill Creek above Ligonier. A large part of the borough is served by combined sewers, some of which are private, but all laid without regard to any prepared comprehensive plan. About one-half of the houses have privies, many of which are connected with private sewers. Garbage is thrown out indiscriminately. Loyalhanna Creek from Latrobe to its junction with the Conemaugh at Saltsburg is a highly polluted stream and at low stages the water is almost inky black. This is the result mainly of mine drainage and water used at the coke ovens, but there are several polluting factors in the vicinity of Latrobe, which, but for the wastes from the coal operations, would produce local nuisances. Even under present conditions, the effect of these wastes on the stream is clearly visible and highly offensive. The washings from rags and waste pulp from the Peters Paper Company's plant above Latrobe pollutes the water and produces a mass of slime and ooze in the creek during low stages. The wastes from the slaughter houses are extensive and particularly offensive being clearly visible in the stream. At the Pierce Manufacturing Company's plant the stream is evidently polluted with dyes.

New Alexandria, Westmoreland County, population 450, is a borough situated on Loyalhanna Creek about ten miles from its mouth, industrially dependent upon extensive coal and coke operations in its vicinity, notably at Salemville, Crab-Tree, and Luxor. There is no public water system. The inhabitants depend upon drilled and dug wells and three springs for water for domestic use. The only sewerage facilities are afforded by two old stone drains, formerly intended for surface and cellar drains only, but now having a number of kitchen wastes and sanitary connections. Well kept privies are in general use; but owing to the percolating nature of the soil there appears to be danger of contamination of some of the wells.

The waters of the streams in the upper portion of this sub-basin beyond the coal mining operations are suitable to sustain fish life and here the State Fish Commission has placed trout, bass, and yellow perch.

There are fifty-nine coal mines in the Loyalhanna watershed. From twenty-five of them the drainage is pumped amounting to 22,915 gallons a minute. There are thirty-four mines that drain by gravity yielding 3,575 gallons a minute, making a total of 26,490 gallons a minute of acid mine drainage discharged into the streams of the State within this basin.

In Table LIII are given the typhoid fever cases reported by the local authorities of the towns in this sub-basin to the State Department of Health for the years 1906 to 1912, inclusive:

TABLE LIII.

Typhoid Fever Cases Reported for the Loyalhanna Creek Sub-Basin, 1906-1912, inclusive.

Town.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
Latrobe,	87	59	110	9	44	36	17
Ligonier,	2	3	2	1	4	3	4
Youngstown,	6	0	0	0	2	0	2

7.—Survey of Conemaugh River Valley—Johnstown to Avonmore.

Along the Conemaugh River from Johnstown to Avonmore are the following municipalities: Johnstown, Ferndale, Dale, Daisytown, Westmont, Rosedale, Brownstown, Seward, New Florence, Garfield, Bolivar, West Bolivar, Derry, Cokeville, Blairsville, Black Lick, Livermore, Jacksonville, Saltsburg, and Iselin.

Johnstown, Cambria County, population about 60,000, is a city situated in the southwestern part of the county at the junction of the Little Conemaugh River and Stony Creek, which here unite to form the Conemaugh River. Clustered about the city and on the streams above and below it are a number of settlements and boroughs which, with the city, form a single community. It is a thriving manufacturing district with numerous industrial plants, the dominant industry being the manufacture of iron and steel and the mining of coal. The three plants of the steel works are practically one enterprise beginning at Franklin and extending down throughout the city, giving employment to about 13,000 men. The company formerly operated ore mines near the city, but they have been practically worked out and ore is now brought in from outside. Coal is extensively mined within the city limits, chiefly by the Cambria Steel Company. The Johnstown Water Company supplies the greater part of the public in the city and neighboring boroughs with water for drinking purposes from various sources, including Mill Creek, Dalton Run, St. Clair Run, Laurel Run, Wildcat Run, and Salt Lick Run, the intakes averaging about five miles in distance from the centre of Johnstown. An auxiliary supply may be and has been obtained from the Manufacturers Water Company and from the Cambria Steel Company, two industrial supplies noted below. Dalton Run, Mill Creek, and St. Clair Run yield the greatest part of this supply. All the watersheds are occupied to a greater or less extent, but sanitary inspections by the Department and the water company and the enforced abatement of many pollutions give assurance of a reasonably pure supply. The emergency supply available through the Manufacturers Water Company

is taken from Stony Creek and that through the Cambria Steel Company from Hinckston Run, both of which supplies are polluted to the extent of rendering them unfit for domestic use unless boiled or otherwise purified. On November 20th, 1908, the Commissioner of Health issued a permit to the Johnstown Water Company approving the sources of supply of the company including a proposed supply from Bens Creek. The Morrellville and Cambria Water Company supplies about 3,000 consumers with water from Struyer Run and a drilled well. The Jerry Alwine private supply derived from two springs is used by 150 persons in the section of the city known as Roxbury. On October 15, 1908, the Commissioner of Health issued a permit to Jerry Alwine for the use of this supply. Beside the public supplied by the various water companies there are many persons in the outlying district dependent on drilled and dug wells. There are three important industrial supplies, the Manufacturers Water Company with intake on Stony Creek near the Somerset County line and supplying various manufacturing plants, the Greenbriar Water Company, supplying the Johnstown Pressed Brick Company with about 6,000 gallons of water daily from a small, impounding reservoir in the outskirts of the city, and the Cambria Steel Company's industrial supply from Hinckston Run, where there is a 1,900,000,000 gallon reservoir. This company is completing an extensive project for deriving an industrial supply from Quemahoning Creek in Somerset County, which, when completed, will include the largest artificial body of water in Pennsylvania. A number of plants in the city have private drilled wells which supply water for industrial purposes. The city is more or less completely sewered by combined sewers receiving both sewage and storm water and discharging into the various streams within the city. These streams are contaminated by mine drainage and are yellow in appearance.

The principal boroughs and villages in the vicinity of Johnstown, and properly belonging to the same community, include Ferndale, Dale, Daisytown, Westmont, Rosedale, and Brownstown.

Ferndale, Cambria County, population about 320, is a borough situated on Stony Creek south of and adjoining the Seventeenth ward of Johnstown. It is a residential suburb deriving its water supply in part from the Johnstown Water Company and partly from wells and springs. A portion of the borough is served by a small system of public sewers with an outlet to Stony Creek. There are also a number of private drains discharging sewage and kitchen waste to the highways or Stony Creek.

Dale, Cambria County, population 2,200, is a borough adjoining Johnstown on the southeast, drained by Solomon Run which passes through the borough and thence through a portion of Johnstown into Stony Creek. It is a suburban, residential community supplied with

water by the Johnstown Water Company except in the most elevated portions where individual dug and drilled wells are used. The borough has a combined system of sewers serving about three-quarters of the population through four outlets, three into Solomon Run and one into a Johnstown City sewer. The remaining population depend upon privies, of which there are about a hundred in use. Many small drains discharge kitchen waste and in some cases sewage to the run or to the street gutters.

Daisytown, Cambria County, population 350, is a residential borough adjoining the city of Johnstown on the east. There is no public water supply, the inhabitants depending upon the use of three drilled wells and perhaps thirty-five dug wells. The town is also without sewers. The privies which are in general use are dug in gravelly soil and seldom or never overflow. Some kitchen waste reaches the highways.

Westmont, Cambria County, population 1,500, is a residential borough on the heights overlooking the central portion of Johnstown, with which it is connected by an inclined plane. Water is supplied by the Johnstown Water Company to the entire population. The borough has a system of sanitary sewers aggregating some five miles and a half with three outlets, two into Stony Creek, twelve inches and fifteen inches in diameter, and one eighteen inches in diameter into the Conemaugh River, just below the mouth of Stony Creek. It is proposed to extend the system and construct an additional outlet two feet in diameter into Stony Creek. The entire population is served by the sewers.

Rosedale, Cambria County, population about 390, is situated due north of and adjoining the city of Johnstown. It is a borough located in the narrow valley of Hinckston Run which flows the entire length of the borough, about a mile and a half. The inhabitants are dependent for water for domestic purposes upon a large number of springs and to some extent upon private wells. There are no public sewers and but one private sewer which discharges into an abandoned mill race. About half the privies have cement vaults; the remainder are board lined. There are a number of individual drains discharging sewage and kitchen waste into the race or run.

Brownstown, Lower Yoder Township, Cambria County, is an unincorporated village with a population of about 2,300, adjoining the western boundary of the borough of Westmont. The inhabitants are largely foreigners and the less resourceful class of employees of the Cambria Steel Company, the houses extending in tiers up the steep hillside. The Johnstown Water Company supplies water throughout the settlement, but a number of springs, several of which are visibly polluted, are largely used for drinking purposes. There is no sewer system and the privies are shallow excavations in shale and rock,

consequently subject to frequent overflow. The kitchen waste, slops and garbage are thrown indiscriminately to the streets and ground on the hillside and the main highway, and along the latter is a ditch receiving much of the pollution including that washed down by every rain. Out of some 350 houses in this thickly settled section 222 dispose of their wastes in an unsanitary manner.

Seward, Westmoreland County, population 500, is a borough situated about a quarter of a mile from the south side of the Conemaugh River and about three miles below the county line. The inhabitants depend for employment upon the Pennsylvania Railroad, three neighboring coal mines, and the Seward Brick Company whose plant employs about seventy-five persons. There is no public water system, each house having its individual dug well, except that a hotel and one residence are supplied by a private pipe line from a mountain spring. The borough has no public sewers, but there are two private six-inch sewers receiving surface, roof and cellar drainage and some sewage and kitchen waste from about ten properties. These sewers discharge in the open fields about 1,500 and 2,000 feet respectively from the river, where the soil is porous and the wastes quickly disappear. The hotel has a percolating cesspool and other properties have brick lined privies dug in porous soil. In some cases kitchen waste finds its way into the highways and runs, but usually enters the soil.

New Florence, Westmoreland County, population 1,000, is a borough situated on the south bank of the Conemaugh River in the northeast part of the county. Industrially the town is dependent chiefly upon the Pennsylvania Railroad. Water is furnished to the public by the New Florence Water Company from a 1,000,000 gallon reservoir with uninhabited watershed on Baldwin Run about two miles from the borough. Aside from those using some six dug wells, the inhabitants are supplied entirely by the water company, the consumption being estimated at about 40,000 gallons a day. There are no public sewers, but many small drains used chiefly for kitchen waste discharge into the river or into the highways, mainly the latter. There are perhaps 175 privies, for the greater part dug in hard soil and in many cases overflowing and causing considerable surface pollution.

Garfield, West Wheatfield Township, Indiana County, population 1,000, is an unincorporated town located on the northern banks of the Conemaugh River nearly opposite but slightly east of Bolivar, Westmoreland County, with which it is connected by a bridge. Garfield, the borough of Bolivar, and West Bolivar village are practically one community, and all are interested primarily in the manufacture of fire brick. There are two large fire brick plants at Garfield, the Garfield Fire Brick Company employing about 150 men and a plant

formerly owned by the Reese-Hammond Fire Brick Company, but temporarily closed. Water is supplied to the public by the Mace Springs Water Company, which also supplies Bolivar and West Bolivar. About half the population of Garfield use this supply, which is derived from two small tributaries of Tub Mill Creek in Westmoreland County with two impounding reservoirs of 2,500,000 gallons and 1,000,000 gallons capacity. The remainder of the population derive their supply from some twenty dug wells. To the surface pollution of one or more of these wells was attributed an epidemic of typhoid fever which occurred some years ago. Privies are in general use, in many cases overflowing or overhanging one of the three small runs traversing the village. The highways or runs also receive kitchen waste, largely by way of small drains.

Bolivar, Westmoreland County, population 950, is a borough situated on the south bank of the Conemaugh River at the mouth of Tub Mill Creek. The borough's industries comprise a large plant of the Bolivar-Clearfield Brick Company, formerly the Reese-Hammond brick plant, the Bolivar Foundry and Machine Company, the Bolivar Heat, Light and Power Company, and the U. S. Enamel Brick Company. Water is supplied to the public by the Mace Springs Water Company, derived from two tributaries of Tub Mill Creek, with two impounding reservoirs of 3,500,000 gallons combined capacity. Public water is generally used. The borough has a system of combined sewers with which about 150 houses are connected, sixty of which have inside closets. This system has two outlets eighteen inches and fifteen inches in diameter, into Tub Mill Creek, the former about 200 feet from the mouth of the creek, the latter some 2,000 feet above. There are about 120 privies in use; some thirty have water tight, cement lined vaults and about the same number are lined with plank, the remainder being dug in clay soil. Considerable pollution arises from overflowing privies and there are a number of instances of kitchen waste discharging into the highway.

West Bolivar, Fairfield Township, Westmoreland County, population about 500, is an unincorporated, residential town adjoining the borough of Bolivar on Tub Mill Creek. The village has no industries, the inhabitants being employed chiefly at Bolivar. The principal sources of water for domestic use are individual dug wells, but a portion of the people are supplied by the Mace Springs Water Company which furnishes water to Bolivar from tributaries of Tub Mill Creek. The village has no sewers except a number of small drains for kitchen waste, discharging into the highway. There are at least two overflowing privies, sewage from one reaching the highway and the other Tub Mill Creek.

Derry, Westmoreland County, population 2,900, is a borough situated about six miles east of Latrobe and about the same distance south of Blairsville on Magee Run, a tributary entering the Cone-

maugh River just above the latter town. The borough is a division point of the Pennsylvania Railroad system and about 500 men find employment there, beside which the American Window Glass Company employs about 100 men and the Sevres China Company employs about 200. Water is supplied to the public by the Derry Water Company, a corporation operated by the Westmoreland Water Company; but having no connection with the latter company's main system. The sources of supply are Magees Run and one of its tributaries, Millwood Run, in the mountains about Derry. The reservoirs on these streams have about 2,250,000 gallons and 2,500,000 gallons capacity. For locomotive and steam use there is also an industrial supply derived from Ethel Springs, a small tributary of Magee's Run with two reservoirs of 196,000,000 gallons and 600,000 gallons capacity. Heretofore there have been no public sewers in Derry, but about 200 small private sewers have emptied into the two runs in the borough and probably 2,000 persons use privies of a shallow type, almost universally overflowing. The street gutters were generally in a foul condition and the streams of the borough badly polluted. As a result of these conditions and in accordance with decrees issued by the Commissioner of Health, April 29, 1907, March 2, 1908, and May 28, 1908, the borough has constructed a system of sanitary sewers and disposal works composed of sedimentation tanks and contact filters with fifteen-inch outlet into Magee Run below the borough limits. The Derry Land Company's tract just outside of the borough limits in Derry township, has a population of about 225 persons who are negotiating for the privilege of connecting with the Derry system. At present their sewage is discharged into a branch of Magee's Run above the borough.

Cokeville, Westmoreland County, population about 500, is a borough situated on the Conemaugh River at the mouth of Magee's Run and about one mile above Blairsville, formerly depending upon coal and coke operations in its immediate vicinity which are now abandoned. Many of the residents find employment in Blairsville, as there are no active industries of importance in the borough. There is no water supply system and dug wells are universally used. Board lined privy vaults are in general use and kitchen waste is discharged largely to the ground except that there are twenty or more small drains discharging from individual properties into ditches, the old canal bed, or the river. A slaughter house on the bank of the river discharges its wastes thereto.

Blairsville, Indiana County, population about 3,500, is a borough located on a level plateau on a neck of land enclosed in a loop of the Conemaugh River, the river forming the easterly and westerly boundaries. The principal industrial enterprises in the borough are the Columbia Plate Glass Company with several hundred employees,

and the Blairsville Enamel Company employing about a hundred persons. The borough has a municipal water works system whose source of supply is the Conemaugh River above the borough. Water is pumped through a sixteen-inch suction pipe having a strainer on its end submerged twelve inches below extreme low water and raised by means of three pumping engines with a total capacity of 3,250,000 gallons a day to a 169,000,000 gallon masonry reservoir from which water flows by gravity through the distribution system. This source will be abandoned soon for a drilled well supply. About 300 persons rely entirely upon private wells or springs and 300 more use the public supply in part, the remaining population depending entirely upon the public system. The reservoir has a capacity less than the daily consumption thus affording little or no sedimentation, and any pollution existing in the Conemaugh River might pass directly into the street mains. Water drawn from the taps in the town is turbid at times when the river water is turbid. On June 10, 1907, the Commissioner of Health called the attention of the borough authorities to the necessity for safeguarding the public health by the installation of an approved water purification plant and that meantime the public should be warned that all water used for drinking and culinary purposes should be boiled.

The borough has an incomplete system of combined sewers. There are about 900 buildings in the borough and some 400 are connected with the sewers. Also there are 477 privies, some of which have sewer connections. Less than half the population live in dwellings with sewer connections. Over five-eighths of the built-up portion of the town is reached by sewers aggregating about five miles and a half with four public and two private sewer outlets into the river and two public and three private outlets into Sulphur Run. The public sewer outlets range in size from six inch tile to a three foot by five foot brick culvert, the latter forming the principal sewer and enclosing a portion of the stream known as Bloody Run. On June 10th, 1907, the Commissioner of Health issued a permit for an extension of certain sewers and requiring the preparation of plans for the ultimate treatment of the sewage. Liquid wastes from the Blairsville Enamel Company's plant are discharged into Sulphur Run after some effort at treatment.

Black Lick, Burrell Township, Indiana County, population about 400, is an unincorporated village at the confluence of Two Lick and Black Lick Creeks about six miles from the point where Black Lick Creek discharges into the Conemaugh River. It is an old, rural community with no industries, although in a measure dependent on the extensive operations of the Josephine Furnace Company at Josephine, about one mile east of this point on Black Lick Creek. There is a small water power development here on Black Lick Creek. Water

for domestic use is obtained from dug wells and a few drilled wells and springs. Every house has a privy dug in percolating soil. There are no public sewers and but one private sewer which, however, receives only the kitchen waste from about fifteen properties. From some twelve other properties kitchen wastes are discharged on to the highways.

Livermore, Westmoreland County, population about 300, is a borough situated on the south bank of the Conemaugh River about six miles below Blairsville. The borough has no industrial plants. Water for domestic use is obtained from private, dug wells, of which there are about thirty in use. There are no public sewers and but four private sewers from individual properties discharging sewage, although there are a large number of small drains for kitchen waste. One of the four private sewers discharges into a cesspool. Approximately forty-two privies are in service.

Jacksonville, Indiana County, population about 90, is an inland borough about seven miles north of the Conemaugh River on Aultmans Run. It is a rural community without industries, although the extensive coal deposits give promise of early activity. Water is obtained from private, dug wells and two drilled wells. Each of the twenty-four houses in the borough has a well kept privy vault dug in gravel or shale, and there are no sewers. It is reported that five properties drain kitchen waste into the highway.

Saltsburg, Indiana County, population about 1,400, is situated in the southwestern corner of Indiana County on the north bank of the Conemaugh River opposite the point where its confluence with Loyalhanna creek forms the Kiskiminetas River. The Saltsburg Bottle Works employing about 70 men and the Saltsburg plant of the American Sheet Steel Company employing about 170 men are the chief industrial features of the town. The borough has a municipal water works system deriving its supply from the Conemaugh River at a point above the sewer outlets. Crude river water is raised by means of two pumping engines, operated about two days each week, to the distributing reservoir which holds a supply for about thirteen days. During the period of pumping the water is delivered directly to the mains, the surplus only coming to the reservoir. The daily consumption is about 75,000 gallons. It is estimated that 1,100 persons are supplied with public water, the remainder using wells and springs. The rolling mill of the American Sheet and Tin Plate Company has an industrial supply drawn from the Conemaugh River amounting to about 100,000 gallons a day, of which about six-tenths is returned to the river with little or no pollution. The borough has a public sewer system receiving both sewage and storm water and discharging by way of four outlets into the river, and serving about 750 persons or three-fourths of the population in

the sewer district, the remainder using shallow privies. On June 10th, 1907, the Commissioner of Health issued a permit for the construction of an additional outlet sewer, but requiring the preparation of plans for a comprehensive sewerage system having for its ultimate object the interception and purification of all the borough sewage.

Iselin, Young Township, Indiana County, population 1,300, is a new, unincorporated village in the southwestern part of Indiana County on Hooper's Run, a tributary of Black Leg Creek. The town has been built up as a result of operations of the Pittsburgh Gas Coal Company, which owns all the property, including about 200 houses. The coal company has a water supply system with an intake dam on Hooper's Run below the town, from which water is piped to a filter plant, and thence pumped to a distributing reservoir. The filter is a one unit plant with a capacity of 6,000 gallons, the present consumption being about 5,000 gallons. Beside this supply there are some seven or eight springs which furnish probably two-thirds of the population with drinking water. Privy vaults are in general use, several of the older ones being unsanitary due to overflowing. There are no public sewers and but four properties connected with private sewers, these discharging into Hooper's Run. Some surface pollution is likely to reach the stream above the water works intake, but considerable care is taken to prevent this.

Along this valley of the Conemaugh River from Johnstown to Avonmore there are thirty-seven coal mines, the drainage of which is pumped from four amounting to 1,440 gallons a minute. The drainage from the remaining thirty-three mines is by gravity and it amounts to 3,170 gallons a minute or a total of 4,610 gallons a minute being discharged into the river in this section. We may therefore make a summary of the coal mining operations in the Kiskiminetas watershed above Avonmore as follows:

District.	Coal Mines.	Discharge of Mine Drainage. Gallons per Minute.
Above Johnstown,	176	45,324
Loyalhanna Creek,	59	26,480
Black Lick Creek,	68	14,350
Between Johnstown and Avonmore,	37	4,610
Total,	340	90,784

The Cambria Steel Company has made chemical analyses of the Conemaugh River water at Coopersdale in the lower part of Johnstown City. In Table LIV results of these analyses are shown:

TABLE LIV.

Chemical Analyses of Conemaugh River Water.

Parts per Million.

(Conemaugh at Coopersdale, Lower Part of Johnstown City.)

	Feb. 8, 1904.	Nov. 19, 1904.	Dec. 3, 1894.	Dec. 21, 1904.	Jan. 24, 1905.	June 24, 1905.	Aug. 24, 1906.	Sept. 25, 1906.
Iron and Alumina,	191.8	7.8	23.2	16.0	42.4	6.3	15.6	30.4
SiO ₂ ,	63.2	164.4	134.4	196.1	55.2	22.0	54.9	84.4
Manganese,	26.5	80.6	82.2	76.2	22.5	16.6	28.8	70.8
Silica,	6.2	22.2	22.8	28.2	6.3	12.1	24.4	17.8
Free Acid,	187.8	7.2	52.0	13.6	55.2	16.0	12.8	68.4
Organic Matter,	4.1	.....	.....	6.8	None.	3.3	4.95	3.2
Chlorine,	217.0	.....	.....	15.8	.....	.....	.....	.....
Total Solids,	6.0	18.4	17.2	32.0	2.3	.....	.....	.....
	707.2	303.0	360.8	332.0	225.0	75.4	163.8	301.3

The Cambria Steel Company has also made analyses of the Cone-
maugh River water just below the City of Johnstown at No. 1 Blast
Furnace. The results of these analyses are given in Table LV:

TABLE LV.

Chemical Analyses of Conemaugh River Water at Johnstown.

Parts per Million.

(Conemaugh just below Johnstown. No. 1 Blast Furnace Supply.)

	Nov. 19, 1902.	Feb. 15, 1904.	Nov. 19, 1904.	Dec. 3, 1904.	Dec. 21, 1904.	Jan. 14, 1905.
Iron and Alumina,	5.5	16.4	18.8	8.4	26.4	22.6
SO ₂ ,	63.8	31.0	149.7	9.1	199.2	185.6
Lime,	43.2	19.0	78.0	9.2	75.4	63.7
Magnesia,	15.2	8.3	22.8	6.2	27.5	22.6
Silica,	6.9	8.8	14.4	9.6	17.6	78.0
Free Acid,	None.	2.6	.....	.....	12.5	11.0
Organic Matter,	21.2	13.4	.....	.....	.....	.....
Chlorine,	8.0	.....	23.4	4.0	18.7	4.0
Total Solids,	165.0	99.5	325.0	57.0	332.8	328.9

	Jan. 24, 1905.	Feb. 13, 1905.	Feb. 24, 1905.	Mar. 11, 1905.	Mar. 24, 1905.	Apr. 10, 1905.
Iron and Alumina,	37.4	16.0	26.0	21.0	22.2	75.2
SO ₂ ,	51.9	78.9	74.7	40.0	39.4	36.0
Lime,	54.1	34.0	31.2	18.8	19.9	20.6
Magnesia,	10.4	22.8	19.8	10.2	6.3	28.0
Silica,	17.7	13.8	19.2	30.4	27.9	69.6
Free Acid,	None.	None.	3.3	3.3	None.	4.9
Organic Matter, .....	.....	.....	.....	.....	.....	.....
Chlorine,	3.0	2.1	2.2	.....	.....	.....
Total Solids,	211.4	204.2	205.2	171.2	155.6	304.6

	May 10, 1905.	June 10, 1905.	July 24, 1905.	Aug. 24, 1905.	Sept. 25, 1905.
Iron and Alumina,	43.6	26.3	28.2	20.0	21.6
SO ₂ ,	43.8	20.2	61.8	55.8	70.2
Lime,	21.8	30.1	28.4	20.0	74.0
Magnesia,	14.0	13.6	21.0	19.2	16.6
Silica,	58.4	42.8	29.0	11.6	16.2
Free Acid,	3.3	None.	6.6	4.95	3.3
Chlorine, .....	.....	.....	.....	.....	.....
Total Solids,	238.6	228.0	222.2	176.2	215.8

The Wm. B. Scaife & Sons Company has analyzed the Conemaugh River water at Blairsville for the Columbia Plate Glass Company. In Table LVI the results are given:

TABLE LVI.

Chemical Analyses of Conemaugh River Water at Blairsville.
Parts per Million.

	Dec. 4, 1908.
Volatile and Organic,	2.6
Silica,	9.4
Iron and Al. Oxides,	1.7
Calcium Oxide,	102.6
Magnesium Oxide,	36.2
Sodium Oxide,	31.6
Sulphuric Anhydride,	238.7
Carbonic Anhydride (Fixed),	None.
Carbonic Anhydride (Free),	9.4
Chlorine,	18.8
Nitric Anhydride,	Trace.
Alkalinity as Calcium Carbonate,	None.
Acidity as Sulphuric Acid,	None.
Calcium Carbonate,	None.
Calcium Sulphate,	249.1
Magnesium Sulphate,	108.8
Sodium Sulphate,	34.9
Sodium Chloride,	31.0
Total Solids,	437.4
Suspended Matter,	24.8
Free Carbonic Acid,	9.4
Incrusting Solids,	371.6
Non-incrusting Solids,	65.8

The local health authorities of the principal places along the valley of the Conemaugh River from Johnstown to Avonmore have reported typhoid fever cases to the State Department of Health for the years 1906 to 1912, inclusive. These reported cases are shown in Table LVII:

TABLE LVII.

Typhoid Fever Cases Reported for the Conemaugh Valley, Johnstown to Avonmore,
1906—1912, inclusive.

Town.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
Johnstown,	240	206	272	160	135	64	46
Brownstown,	0	0	1	0	14	7	3
Daisytown,	0	0	4	1	1	2	0
Dale,	0	0	4	2	13	2	1
Rosedale,	0	0	1	0	6	0	0
Westmont,	0	3	28	2	1	4	1
Blairsville,	9	16	14	7	4	8	10
Jacksonville,	0	0	1	0	0	0	0
Derry,	0	3	3	3	5	0	1
New Florence,	0	0	1	1	2	0	1
Livermore,	0	0	0	1	0	0	0
Seward,	0	0	0	1	2	0	0
Cokeville,	0	0	0	0	0	2	1
Bolivar,	0	0	0	0	0	0	1

8.—*Survey of Kiskiminetas River Valley—Avonmore to Allegheny River.*

In this stretch of the Kiskiminetas Valley are the following places: Avonmore, Apollo, Vandergrift, Vandergrift Heights, East Vandergrift, Hyde Park, and Leechburg.

Avonmore, Westmoreland County, population 1,100, is a borough situated on the south bank of the Kiskiminetas River about four miles below the mouth of Loyalhanna Creek. It is an industrial community dependent chiefly upon three plants: the tin plate works of the Alcania Company with about 180 employees manufacturing about 6,000 tons of tin plate a year, the West Penn Foundry Company, and the Avonmore Cast Steel Company. Domestic and industrial water supplies are drawn from private wells. The borough constructed during the year 1909, a municipal water works system consisting of a series of drilled wells. The wells are four in number from which the water is pumped into a water tank. From this tank the water is forced directly into the mains, the surplus passing into a reservoir whence it flows by gravity into the distribution system when the pumps are not operated. The four drilled wells are located on flat land within an area of about two acres directly beyond the build-up residential portion of the borough. They are from 150 to 250 feet deep and are cased to within four feet of the bottom. From these wells 500,000 gallons of water a day can be pumped. The system has been approved by the State Department of Health.

There are four public combined sewers in the town, all of which discharge into a small run tributary to the river. One of these is six inches in diameter and extends easterly on Allegheny Avenue for 600 feet. It was built in 1907. An eight-inch sewer extends westerly on Indiana Street 1,800 feet. Another eight-inch sewer extends westerly on Railroad Avenue 900 feet. A nine-inch sewer extends westerly on Westmoreland Avenue 1,300 feet. Connected with this sewer is a six-inch lateral on Fifth Street. There are a number of cesspools in the borough and the common shallow privy vault is in almost universal use. Industrial wastes of importance are contributed by the Alcania Company where from 3,000 to 4,000 pounds of concentrated sulphuric acid a day are used in the pickling process, the spent acids being discharged through a sewer into a pool whence the liquid percolates through the soil into the river.

Apollo, Armstrong County, population about 3,000, is a borough situated on the north side of the Kiskiminetas River and about twelve miles from the mouth of that stream. It has no industries except a woollen mill and two flour mills, the inhabitants being largely employed a short distance down stream at the large manufacturing

plants in Vandergrift and Leechburg. Water is supplied by the Apollo Water Works Company, a subsidiary company of the Pennsylvania Water Company, and is furnished to the greater portion of the inhabitants, although a few private dug wells are in use. The source of supply is Beaver Run, a tributary entering the Kiskiminetas River opposite Apollo in Westmoreland County. On this run there is an earth dam with stone masonry core wall about thirty feet in height or twenty feet to the spillway. The impounding reservoir thus formed has a capacity of 70,000,000 gallons. A sixteen-inch pipe leads the water from this reservoir to a slow sand filter plant consisting of two units of 1,000,000 gallons capacity each, only one of which is operated at a time. This water is then pumped to a 13,000,000 gallon reservoir from which it flows by gravity through a twelve-inch main to Apollo, and through another main to Leechburg. The Leechburg Water Company purchases its supply from the Apollo Water Works Company. It is reported that there are about 500 taps and two factories supplied with this water in Apollo. The borough has a combined system of storm and sanitary sewers serving most of the properties nearly all of those not so connected having private sewer outlets, of which there are twenty or more with about thirty-five properties connected, the outlets being into the river or into a badly contaminated stream called Sugar Run. There are also a large number of small sewers for kitchen waste discharging mainly into the stream.

Vandergrift, Westmoreland County, population 2,800, is an industrial borough situated on the south bank of the Kiskiminetas River about ten miles from its mouth. Industrially it is mainly dependent upon the American Sheet and Tin Plate Company, employing over 3,000 men with a weekly output of about 3,500 tons of black and galvanized sheets. Other industries are the United Engineering and Foundry Company, 400 employees, and the planing mill of the Vandergrift Lumber Company with about ten employees. Water for domestic use is supplied to the public by the Vandergrift Water Company and is used by practically the entire population. The source of supply is in ten wells drilled in the vicinity of Pine Run from which the water is pumped to a mechanical filtration plant consisting of two Jewell Filter Units and one Roberts Filter. There are three distributing reservoirs, two of them consisting of iron tanks with a capacity of 338,400 gallons each and one wooden tank of 50,000 gallons capacity. This water is furnished also to the boroughs of East Vandergrift and Vandergrift Heights. Industrial supplies are drawn from the river by the American Sheet and Tin Plate Company and by the United Engineering and Foundry Company, the former said to use 18,720,000 gallons of water a day, ninety-six per cent. of which is returned to the stream. The borough has a comprehensive

and complete system of combined sewers to which every dwelling is connected as well as street inlets. No outside privies are used. The sewer system discharges into the river through a single outlet at the lower end of the borough and just above the plant of the American Sheet and Tin Plate Company. A pond near this point which was formerly connected with the river, has its outlet closed. Considerable kitchen waste and some sewage has been discharged into this pond at times creating offensive conditions. The liquid wastes from the tin plate works amounting to over 34,000 gallons a day, so it is reported, contain less than one per cent. of free acid. These wastes are the spent liquors from the pickling process in which muriatic and sulphuric acids are used.

Vandergrift Heights, Westmoreland County, population about 3,000, is a borough situated on the bluff south of the Kiskiminetas River immediately south of Vandergrift Borough. It is a residential town, the inhabitants being mainly employees in the large industrial plants at Vandergrift and vicinity. Practically the entire population is served with water by the Vandergrift Water Company, there being about 650 taps in the borough. There are no public sewers and but one private sewer, the latter having fourteen or more dwellings connected with it and discharging into Frozen Hollow Creek about a quarter of a mile from the river. Another stream, a small run, passes through the centre of the borough discharging into the river through the property of the Tin Plate Company. Probably three-quarters of the houses in the borough have individual drains discharging kitchen waste, bath waste, and in some cases closet sewage into the highways and thence to this run, and some of them to Frozen Hollow Creek. At the time of the Department's inspection, in March, 1907, the sanitary condition of the borough was very bad. Since then conditions have improved.

East Vandergrift, Westmoreland County, population about 580, is a residential town on the south bank of the Kiskiminetas River. Water is supplied by the Vandergrift Water Company to about eighty connections, the greater part of the population, however, depend on driven wells and springs. There are no sewers except a few private drains for kitchen waste discharging into the highways or the river.

Hyde Park, Westmoreland County, population about 350, is a borough situated on the south bank of the Kiskiminetas River about six miles from its mouth. It is an industrial town having a number of plants whose employees reside in Hyde Park and the neighboring boroughs. The industries include a plant of the American Sheet and Tin Plate Company, manufacturing about 360 tons a week of black sheets and giving employment to about 225 men, the Hyde Park Foundry and Machine Company employing about 50 men, the Hyde Park Brewing Company with about 22 persons employed, the Em-

pire Brick Company with 25 employees and two new plants in course of construction in March, 1907, the Michigan Car Roofing Company and the Block Tile Company. The borough has no public water supply. An industrial supply is drawn from the river by the American Sheet and Tin Plate Company amounting to about 150,000 gallons a day of which about three-fifths is said to be returned to the stream. The only public sewer is a two-foot storm drain and the only private sewers noted are a ten-inch sewer from the Hyde Park Hotel, a twelve-inch sewer from the American Sheet and Tin Plate Company's plant and a twelve-inch sewer from the Hyde Park Brewing Company. It is said that the only wastes from the plant of the tin plate company consist of sewage from the closets.

Leechburg, Armstrong County, population about 2,800, is a borough situated on the north bank of the Kiskiminetas River about five miles from its mouth. It is an industrial community whose manufacturing plants include works of the American Sheet and Tin Plate Company employing 410 persons in the manufacture of black plate and the Pittsburgh Shovel Company employing about 80 men. Water is supplied through 500 service taps, to the public, by the Leechburg Water Company, a corporation owned and operated by the Pennsylvania Water Company in connection with the Apollo Water Works Company, another subsidiary concern. The Leechburg Water Company obtains a supply from the Apollo Water Works Company which is derived from Beaver Creek and subjected to filtration. This supply has been considered above under the description of Apollo Borough. The American Sheet and Tin Plate Company has a private industrial supply from the Kiskiminetas River amounting to 300,000 gallons a day. The borough is quite extensively sewered with a combined system, with a single thirty-inch outlet and two storm water overflows. The overflow outlets enter the river near the upper end of the borough and near the centre, respectively, and the sanitary outlet is near the lower end. Beside the public sewers there are a large number of individual private sewers discharging sewage in some cases, but mainly kitchen waste, into the river, and there are a number of instances of kitchen waste discharged into the highway. The Tin Plate Works and the Shovel Plant each have private sewers for sewage and industrial waste. There are many privies overhanging or directly polluting the river or a small run. It is reported that the plant of the Tin Plate Company has no manufacturing wastes other than water used for cooling purposes, but there is said to be a small amount of oil of vitriol in the wastes from the Pittsburgh Shovel Company's plant. At the village of West Leechburg, Westmoreland County, across the river from Leechburg, Armstrong County, is located the plant of the West Leechburg Sheet and Tin Plate Company. This company derives a private, industrial supply from the river.

Along the Kiskiminetas River valley from Avonmore to the Allegheny River there are forty-four coal mines. The drainage from six of these mines is pumped amounting to 950 gallons a minute. The remaining thirty-eight mines drain naturally, the volume discharged amounting to 4,585 gallons a minute. Hence the total of 5,535 gallons a minute of mine drainage is discharged into the waters of the State in this section of the Kiskiminetas River basin.

There are, therefore, in the entire Kiskiminetas River drainage area 384 coal mines discharging nearly 100,000 gallons of acid mine drainage a minute into the waters of said basin.

The American Sheet and Tin Plate Company has analyzed the waters of the Kiskiminetas River at Vandergrift. In Table LVIII the results of some analyses of water during a low stage of the river in 1907 and a high stage of the river the same year and a low stage of the river for the following year, are given:

TABLE LVIII.
Chemical Analyses of Kiskiminetas River at Vandergrift.
Parts per Million.

Determination.	Vandergrift Low River Water Aug. 2, 1907.	Vandergrift High River Water Sept. 8, 1907.	Vandergrift Very Low River Oct. 24, 1908.
Color,	Clear.	Muddy.	Clear.
Odor,	Odorless.	Odorless.	Odorless.
Reaction,	Acid.	Acid.	Acid.
Acidity H_2SO_4 ,	44.1	14.0	65.4
Chlorine,	15.0	6.0	.....
Total Solids,	258.0	107.0	925.0
Total Ammonia, .....	.46	.....	.....
Free Ammonia, .....	.88	.....	.....
Albuminoid Ammonia, .....	.06	.....	.....
Nitrites,	Trace.	.....	.....
Nitrates,	Trace.	.....	.....
Suspended Matter, .....	.....	44.0	.....
Constitution of Total Solids.			
Loss on ignition CO_2 ,	98.0	18.0	260.0
Silica,	5.0	4.4	12.0
Iron and Aluminium Oxides,	10.32	2.8	43.0
Lime,	34.96	23.0	169.0
Magnesia,	13.60	7.68	60.0
Sulphuric Anhydride,	72.72	49.03	369.0

Note—The high river water was filtered for analysis so that the soluble salts could be compared with the analysis of August 2d, 1907.

During the years 1908 and 1909 the American Sheet and Tin Plate Company collected samples of water of the Kiskiminetas River every month and determined the acidity of these samples. In Table LIX are given the results of these analyses:

TABLE LX.

Chemical Analyses of Kiskiminetas River at Vandergrift as to Acidity.
Parts per Million.

Determination.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1907.												
Free Acid,											5.1	5.1
Total Acid,												
1908.												
Free Acid,	6.8	6.8	3.4	3.4	5.1	13.7	29.1	22.6	49.6	59.8	41.0	23.9
Total Acid,									148.8	255.2	136.8	
1909.												
Free Acid,	13.7	22.2	35.9	23.9	41.0	30.8	65.0	65.0	42.8	41.0	22.2	25.6
Total Acid,												
				Maximum.	Minimum.							
Free Acid,				66.7								
Total Acid,				256.5	Neutral.	86						

During a period of eight weeks in the later spring of 1912 the American Sheet and Tin Plate Company collected samples of the Kiskiminetas River Water at Vandergrift and determined the free acid content of the samples. The results are given in Table LX:

TABLE LX.
Chemical Analyses of Kiskiminetas River at Vandergrift as to Free Acid.

Date.	Grains per Gallon.	Date.	Grains per Gallon.
April 29, 1912,.....	0.8	May 30, 1912,.....	1.5
April 30, 1912,.....	0.4	May 31, 1912,.....	1.2
May 1, 1912,.....	0.3	June 1, 1912,.....	1.5
May 2, 1912,.....	0.2	Weekly Ave.	
May 3, 1912,.....	0.4	June 3, 1912,.....	1.3
May 4, 1912,.....	0.4	June 4, 1912,.....	1.5
0.43 Weekly Ave.		June 5, 1912,.....	2.1
May 6, 1912,.....	0.6	June 6, 1912,.....	1.9
May 7, 1912,.....	0.8	June 7, 1912,.....	1.7
May 8, 1912,.....	0.9	June 8, 1912,.....	1.1
May 9, 1912,.....	0.6	Weekly Ave.	
May 10, 1912,.....	0.6	June 10, 1912,.....	2.2
May 11, 1912,.....	0.5	June 11, 1912,.....	2.2
0.67 Weekly Ave.		June 12, 1912,.....	2.2
May 13, 1912,.....	0.8	June 13, 1912,.....	2.6
May 14, 1912,.....	0.8	June 14, 1912,.....	2.6
May 15, 1912,.....	0.8	June 15, 1912,.....	2.8
May 16, 1912,.....	0.6	Weekly Ave.	
May 17, 1912,.....	0.0	June 17, 1912,.....	0.0
May 18, 1912,.....	0.0	June 18, 1912,.....	0.0
Weekly Ave.		June 19, 1912,.....	0.0
May 20, 1912,.....	0.5	June 20, 1912,.....	0.2
May 21, 1912,.....	0.4	June 21, 1912,.....	0.5
May 22, 1912,.....	0.4	June 22, 1912,.....	0.6
May 23, 1912,.....	0.5	Weekly Ave.	
May 24, 1912,.....	0.6	June 24, 1912,.....	1.0
May 25, 1912,.....	0.8	June 25, 1912,.....	1.3
0.47 Weekly Ave.		June 26, 1912,.....	0.9
May 27, 1912,.....	1.2	June 27, 1912,.....	1.2
May 28, 1912,.....	1.3	1.1 4 days' Ave.	
May 29, 1912,.....	1.3		

The Wm. B. Scaife & Sons Company made mineral analyses of the Kiskiminetas River at Vandergrift and West Leechburg. The results are given in Table LXI:

TABLE LXI.
Chemical Analyses of Kiskiminetas River.
Parts per Million.

Determination.	Vandergrift Sept. 18, 1908.	Vandergrift Dec. 12, 1908.	Vandergrift Sept. 9, 1909	W. Leechburg Sept. 14, 1906.
Volatile and Organic,	12.8	12.8	6.8	3.4
Silica,	6.0	12.8	9.4	9.4
Iron and Al. Oxide,	23.1	42.75	9.4	14.5
Calcium Oxide,	76.95	106.0	68.4	44.4
Magnesium Oxide,	27.0	39.3	11.1	16.6
Sodium Oxide,	19.2	33.5	35.6	7.4
Sulphuric Anhydride,	230.2	346.8	193.2	122.4
Carbonic Anhydride (Fixed),	32.0	47.9	18.8	13.2
Carbonic Anhydride (Free),	17.1	29.1	23.9	7.2
Chlorine,	3.4	2.6	2.6	Trace.
Nitric Anhydride,	186.9	257.5	166.2	107.0
Calcium Sulphate,	81.1	118.0	33.3	49.8
Magnesium Sulphate,	5.5	14.9	46.2	2.4
Sodium Sulphate,	28.2	47.9	39.5	11.8
Sodium Chloride,	5.3	4.1	4.1	.....
Sodium Nitrate,	30.8	52.0	.....	.....
Iron Sulphate,	23.1	51.6	33.2	.....
Alumina Sulphate,	37.8	54.4	29.4	21.0
Acidity as H ₂ SO ₄ ,	379.6	571.7	338.7	199.2
Total Solids,	2.6	25.65	9.4	2.6
Suspended Matter,	32.0	47.0	18.8	13.2
Free Carbonic Acid,	27.8	54.4	29.7	20.1
Free Sulphuric Acid,	316.6	504.8	212.1	185.0
Incrusting Solids,	29.0	66.9	89.8	14.2
Non-incrusting Solids,				

The West Leechburg Steel Company collected samples of the Kiskiminetas River at West Leechburg and analyzed the same chemically. The results are given in Table LXII:

TABLE LXII.
Chemical Analyses of Kiskiminetas River.
Parts per Million.

Determination.	W. Leechburg Nov. 12, 1908.	W. Leechburg July 10, 1909.	W. Leechburg Oct. 8, 1909.
Calcium Carbonate,		123.5	69.4
Calcium Sulphate,	328.3	243.0	367.1
Magnesium Carbonate,		96.3	63.6
Magnesium Sulphate,		12.5	8.4
Free Sulphuric Acid,	179.6	158.7	285.9

The local authorities in the towns of the valley along the Kiskiminetas between Avonmore and the Allegheny River reported cases of typhoid fever to the State Department of Health for the years 1906 to 1912, inclusive. These cases are given in Table LXIII:

TABLE LXIII.
Typhoid Fever Cases Reported for the Kiskiminetas River Valley from Avonmore to Allegheny River, 1906-1912, inclusive.

Town.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
Leechburg,	2	5	19	14	0	2	1 $\frac{1}{2}$
Apollo,	0	1	0	2	2	4	2
Avonmore,	0	4	6	1	0	3	2
Vandergrift,	0	0	0	3	2	4	1
East Vandergrift,	0	0	0	3	0	2	6
Vandergrift Heights,	0	1	3	0	0	0	0
New Salem,	0	0	0	0	0	3	1

(b) *Along Allegheny River.* At the mouth of the Kiskiminetas River, the Allegheny starts on the last stage of its course and flows for a distance of about twenty-four miles, with long, gentle curves, in a southwesterly direction to Brilliant, eight miles above its confluence with the Monongahela to form the Ohio. Along the last sixteen miles of this stretch the banks of the river are continuously settled, this being the most thickly inhabited section of the entire Allegheny basin. In the first part of this course the slopes bordering the river are steep, narrow, and eroded, with rich coal veins exposed along the bluffs. Most of the farms on this section are on the uplands which are well cultivated. The total population of this small portion of the Allegheny basin is 60,200, divided as follows: urban, 38,950; rural, 21,250. Tarentum, population 7,000, New Kensington, population 6,800, and Natrona, population 4,500, are the largest communities.

Two small water power installations exist in this division; one at Worthington and one at Craigsville—both on Buffalo Creek in the western part of Armstrong County.

Several projects for the improvement of navigation on the Allegheny River have received serious consideration by the Federal Government and a considerable amount of work has been done under two of them. Under the first—that of 1870 and 1880—low dams and dykes were constructed to concentrate the flow in one channel and increase the depth over the shoals from the mouth of the river to Warren. About \$263,000 were spent on this work which resulted in making navigation possible during stages of the river from two to three feet lower than was formerly practicable. At present, however, there is little steam-boat traffic above Kittanning. In 1890 and 1896, a project was adopted by the Federal Government for the improvement of the river as far as Tarentum. This work involved the construction of three locks and dams and provides a slack water depth of eight feet. The cost has been upwards of \$2,000,000. Dam No. 1, at Herr's Island, a movable dam of the Chanoin type with bear-trap weirs, was completed January 1st, 1903. Dam No. 2, at Aspinwall, is a fixed concrete dam. It has been in operation since November, 1906. Dam No. 3, at Springdale, a fixed concrete dam, was completed in 1908.

The principal industries include coal mining operations and the manufacture of steel products and glass. There are thirty-nine coal mines in this division from the Kiskiminetas to the Ohio River. At ten of them the drainage is pumped, amounting to 2,095 gallons a minute. From the remaining twenty-nine mines the drainage is by gravity, amounting to 2,950 gallons a minute, or a total of 5,045 gallons of acid mine drainage going into the State waters in this section every minute. There are four steel and iron working plants at Natrona, three plants at New Kensington, two at Parnassus, one at Cheswick, three at Verona and three at Oakmont. There are four glass plants at Natrona and Brackenridge, one at Arnold and one at Springdale. The Tarentum paper mills, the aluminium plant at New Kensington, the Phoenix Clay Company of Parnassus, the National Lead and Oil Company's plant at the same point, the acid works of the Pennsylvania Salt Manufacturing Company at Natrona, and the Pennsylvania Glue Works at Springdale are all extensive.

About eighty-five miles of railroads serve this section, including branches of the Baltimore and Ohio, Bessemer and Lake Erie, Buffalo, Rochester and Pittsburgh, and the Pennsylvania, the latter company operating a line on each side of the river throughout this division. The boroughs have public water supplies and there are numerous private industrial water supplies serving the larger industries. Freeport has filtered public water drawn from the Allegheny

by the Freeport Water Works Company. The Guckenheimer Distillery there has private supplies from the river and from driven wells. Millerstown is supplied with water from driven wells by an individual owner. Worthington has no public water supply, but the Graff Woolen Mill uses water from Buffalo Creek for industrial purposes. Natrona is supplied with spring water by the Natrona Water Company, augmented by a filtered supply from the river. The industrial plants there have private supplies for drinking purposes, either filtered or spring water, and for industrial supplies water is taken from the river. Brackenridge and Tarentum are served with filtered river water by the Allegheny Valley Water Company. The Flaccus Glass Company at Tarentum takes water for industrial purposes from the river. Arnold, New Kensington, and Parnassus are served by the Kensington Water Company from a filter crib in the river. At New Kensington, private industrial supplies are drawn from the river by the American Sheet and Tin Plate Company and the Union Spring and Manufacturing Company, and at Parnassus the National Lead and Oil Company uses water from the river. The Springdale Water Company supplies a few persons at Springdale. The borough is constructing a municipal water works system, the supply being from driven wells. The Heidenkamp Mirror Company secures industrial water from the river. At Cheswick, the Cheswick Water Company supplies a portion of the inhabitants with water from a drilled well. Oakmont and Verona are supplied with water by the Suburban Water Company, whose supply is derived from filter cribs in the river. The water supply of Pittsburgh is taken from the river at Montrose and at Aspinwall. At Nadine the Pennsylvania Water Company draws water from filter cribs in the bed of the river and supplies it to a population of about 70,000 persons living in the suburbs of Pittsburgh and the adjoining boroughs in Turtle Creek valley, the water first being subjected to mechanical filtration.

The State Fish Commission has stocked this section of the Allegheny River with yellow perch, pickerel, pike perch, and bass; the Big Buffalo Creek with trout, bass, pickerel, and yellow perch; the Little Buffalo Creek with yellow perch and trout, and the Pucketta Creek with trout, bass, and yellow perch.

In Table LXIV which follows are given some chemical analyses of the Allegheny River water at Natrona, Tarentum, Braeburn, and New Kensington.

TABLE LXIV.

Chemical Analyses of the Allegheny River at Natrona, Tarentum, Braeburn and New Kensington.
Parts per Million.

Determinations.	Scaife Laboratory.			
	Scaife Laboratory.	Penn. Salt Man. Co. Laboratory.	Oct. 5, 1906. Tarentum.	May 4, 1907. Braeburn.
	June 25, 1906. Natrona.	Dec. 14, 1909. Natrona.		Sept. 25, 1906. New Kensington.
Volatile and Organic,	6.0	6.0	6.0	12.8
Silica,	3.4	3.4	Trace.	6.9
Iron and Aluminum Oxide,	0.9	0.9	Trace.	7.6
Calcium Oxide,	32.8	.....	38.5	33.9
Magnesium Oxide,	9.2	.....	9.2	10.1
Sodium Oxide,	13.8	.....	38.1	41.1
Sulphuric Anhydride,	34.5	.....	44.4	23.9
Carbonic Anhydride (Fixed),	15.0	.....	12.0	38.8
Carbonic Anhydride (Free),	1.9	.....	2.9	3.4
Chlorine,	23.7	.....	48.2	7.2
Nitric Anhydride,	Trace.	.....	Trace.	33.9
Calcium Carbonate,	58.6	15.6	18.3	Trace.
Calcium Sulphate,	58.6	58.7	68.6	1.8
Magnesium Carbonate,	15.7	15.7	13.3	69.8
Magnesium Nitrate,	3.9	3.9	6.8	7.2
Sodium Chloride, .....	.....	.....	.....	18.5
Alkalinity,	37.6	37.6	75.0	2.4
Total Solids,	34.2	.....	34.2	16.9
Suspended Matter,	141.8	141.8	191.0	21.4
Free Carbonic Acid,	26.5	26.1	6.0	146.1
Incrusting Solids,	1.9	1.9	3.8	1.1
Non-incrusting Solids,	104.1	.....	119.0	3.8
	37.6	.....	72.0	128.4
	.....	.....	.....	16.9

TABLE LXV.

Chemical Analyses of Allegheny River at Springdale, Oakmont and Verona.

Determinations.	Wm. B. Scalfe & Sons Co. Laboratory.				
	June 6, 1906, Springdale.	Oct. 8, 1906, Springdale.	Aug. 24, 1906, Oakmont.	Oct. 3, 1906, Verona.	Dec. 7, 1906, Verona.
Volatile and Organic,	7.7	18.0	18.8	14.5	14.5
Silica,	7.7	13.7	7.7	6.0	6.0
Iron and Aluminum Oxide,	1.9	6.0	0.8	1.7	2.6
Calcium Oxide,	60.4	37.6	47.9	38.5	26.7
Magnesium Oxide,	15.4	8.7	18.5	9.9	6.2
Sodium Oxide,	18.5	12.7	19.7	15.9	4.8
Sulphate Anhydride,	19.2	37.3	94.4	35.2	18.5
Carbonic Anhydride (Fixed),	58.3	15.0	1.9	16.9	11.3
Carbonic Anhydride (Free),	3.8	3.8	5.6	7.5	7.5
Chlorine,	18.8	29.5	29.0	25.6	14.7
Nitric Anhydride,	Trace.	Trace.	Trace.	Trace.	1.7
Calcium Carbonate,	87.0	29.5	4.5	21.8	24.5
Magnesium Carbonate,	28.2	63.4	110.0	59.9	31.5
Magnesium Chloride,	32.3	11.1	.....	11.8	0.7
Sodium Sulphate, .....	.....	8.0	8.7	10.1	18.1
Sodium Chloride,	4.5	.....	.....	.....	.....
Alkalinity,	31.0	23.9	37.3	29.1	24.0
Total Solids,	145.4	34.2	4.3	24.0	24.0
Suspended Matter,	207.9	164.7	232.6	158.7	103.3
Free Carbonic Acid,	11.1	9.4	4.6	9.6	24.8
Incrusting Solids,	3.8	.....	.....	.....	7.5
Non-incrusting Solids,	12.4	140.7	176.5	28.8	94.2
.....	35.6	23.3	37.3	29.9	9.1

In Table LXV, the chemical analyses of the Allegheny River at Springdale, Oakmont and Verona are shown. The work was performed in the Laboratory of Wm. B. Scaife & Sons Company. These places are lower down the river than the towns mentioned in Table LXIV. On June 6, 1906, at Springdale, manganese carbonate was determined to be 7.7 parts, manganese oxide 4.8; at Oakmont on August 24th, 1909, magnesium sulphate was determined to be 44.6 parts; and at Verona, on December 7th, 1906, magnesium nitrate was determined to be 2.4 parts in a million.

In Table LXVI are given chemical analyses of the Allegheny River still further down the river at Nadine and Pittsburg with mention of the laboratories where the determinations were made.

In Table LXVII are given chemical analyses of the Allegheny River at Pittsburgh throughout the year 1907.

TABLE LXVI.

Chemical Analyses of Allegheny River at Nadine and Pittsburgh.
Parts per Million.

Determinations.	Scaife Laboratory.		Crucible Steel Co. Laboratory.		Scaife Laboratory.	American Steel and Wire Co.
	Oct. 3, 1906, Nadine.	1906, Pittsburgh.	1896, Pittsburgh.	Sept. 22, 1905, Pittsburgh.		
Volatile and Organic.	5.1	.....	.....	0.9	.....	.....
Silica.	6.8	.....	.....	1.7	.....	61.4
Iron and Aluminium Oxide.	Trace.	.....	.....	Trace.	.....	9.9
Calcium Oxide.	33.3	.....	.....	54.7	.....	.....
Magnesium Oxide.	10.4	.....	.....	9.2	.....	.....
Sodium Oxide.	18.0	.....	.....	58.0	.....	.....
Sulphuric Anhydride.	40.9	.....	.....	55.8	.....	.....
Carbonic Anhydride (Fixed).	6.9	.....	.....	30.1	.....	.....
Carbonic Anhydride (Free).	3.8	.....	.....	9.4	.....	.....
Chlorine.	25.6	.....	.....	51.3	.....	.....
Nitric Anhydride.	Trace.	.....	.....	.....	.....	.....
Calcium Carbonate.	19.8	.....	.....	68.0	.....	.....
Calcium Sulphate.	68.6	.....	.....	56.2	.....	.....
Magnesium Carbonate.	15.7	.....	.....	39.7	.....	.....
Magnesium Sulphate.	.....	.....	.....	.....	.....	.....
Sodium Chloride.	6.8	.....	.....	27.7	.....	19.8
Total Solids.	33.9	.....	.....	84.5	.....	83.3
Suspended Solids.	28.5	.....	.....	68.0	.....	.....
Free Carbonic Acid.	156.8	110.6	72.0	253.1	.....	.....
Incrusting Solids.	4.3	.....	.....	11.1	.....	.....
Non-Incrusting Solids.	3.8	.....	.....	9.4	.....	.....
Free Ammonia.	33.9	.....	.....	135.5	.....	.....
Album. Ammonia.	.....	0.016	0.030	114.6	.....	.....
Sulphur as SO ₃.	.....	0.064	0.120	.....	.....	.....
Chloride.	.....	8.580	7.390	.....	.....	.....
Oxygen Absorbed.	.....	7.0	4.0	.....	.....	.....
Sodium Sulphate.	.....	4.25	6.10	30.1	.....	28.4

TABLE LXVII.

Chemical Analyses of the Allegheny River at Pittsburgh, 1906 and 1907.

Parts per Million.

(By Wm. B. Scaife & Sons Company Laboratory.)

Determinations.									
Nov. 10, 1906.	Feb. 18, 1907.	Mar. 11, 1907.	Mar. 14, 1907.	Apr. 6, 1907.	Apr. 17, 1907.	Aug. 29, 1907.	Sept. 12, 1907.	Sept. 19, 1907.	
Volatile and Organic,	14.5	4.3	21.4	7.7	23.1	18.0	12.8	16.2	11.1
Silica,	7.7	2.6	3.4	4.3	11.1	2.6	4.3	6.6	5.1
Iron and Aluminium Oxide,	0.8	Trace	Trace	1.7	Trace	2.6	6.8	6.6	0.2
Calcium Oxide,	29.1	29.1	20.5	22.2	19.2	20.5	28.5	35.9	24.0
Magnesium Oxide,	7.4	9.2	4.1	7.4	9.8	7.5	5.5	7.1	7.4
Sodium Oxide,	8.4	3.2	11.1	7.4	2.1	4.8	22.1	21.7	24.9
Sulphuric Anhydride,	19.2	29.1	23.2	23.9	18.5	22.2	35.9	50.0	27.2
Carbonic Anhydride (Fixed),	13.5	9.4	7.5	7.5	5.6	17.5	9.4	11.3	9.3
Carbonic Anhydride (Free),	7.5	6.8	5.6	5.6	5.6	5.6	5.6	3.8	8.7
Chlorine,	20.5	14.5	12.1	15.4	10.9	12.0	29.5	27.4	23.9
Nitric Anhydride,	Trace	1.7	3.4	1.7	3.4	1.7	1.7	Trace	1.7
Calcium Carbonate,	28.0	15.5	3.7	9.7	10.9	8.9	7.4	1.9	3.1
Calcium Sulphate,	32.5	49.4	36.5	40.7	31.5	37.8	54.4	84.5	58.1
Magnesium Carbonate,	2.4	5.3	6.2	6.2	1.7	6.8	11.2	20.2	15.4
Magnesium Chloride,	14.5	14.4	.....	9.1	11.5	8.7	.....	3.4	.....
Magnesium Nitrate, .....	.....	2.4	4.6	2.4	4.5	2.4	.....	.....	.....
Sodium Sulphate, .....	.....	1.2	1.2	.....	.....	.....	.....	.....	.....
Sodium Chloride,	15.7	6.2	29.0	11.0	2.9	9.1	83.9	40.9	85.3
Total Solids,	116.5	110.0	103.1	95.8	88.3	96.8	134.7	176.6	142.1
Suspended Matter,	1.1	2.3	2.6	10.3	22.1	9.4	18.2	18.2	18.2
Free Carbonic Acid,	7.5	6.8	5.6	5.6	5.6	5.6	5.6	3.7	8.7
Increasing Solids,	100.7	98.9	87.9	83.7	94.4	87.7	91.1	135.1	93.7
Non-increasing Solids,	15.7	6.2	21.9	11.0	3.9	9.1	43.6	40.9	48.4
Alkalinity,	39.8	21.4	17.1	17.1	12.8	17.1	27.4	35.6	27.2
Sodium Nitrate, .....	.....	.....	.....	.....	.....	.....	.....	.....	.....

TABLE LXVIII.

Chemical Analyses of the Allegheny River Water after being Filtered for Public Consumption at Aspinwall—Pittsburgh.

Parts per Million.

Determinations.	By Wm. B. Searfe & Sons Company Laboratory.	
	Partially Filtered.	Wholly Filtered.
	Sept. 11, 1908.	Apr. 12, 1909.
Volatile and Organic,	9.4	20.1
Silica,	6.0	6.6
Iron and Aluminum Oxide, .....	.08	Trace.
Calcium Oxide, ..	47.9	24.0
Magnesium Oxide,	13.5	3.1
Sodium Oxide,	6.1	6.5
Sulphuric Anhydride,	49.2	15.4
Carbonic Anhydride (Fixed),	18.8	11.2
Carbonic Anhydride (Free),	3.8	1.9
Chlorine,	29.1	12.0
Nitric Anhydride,	Trace.	Trace.
Calcium Carbonate,	42.7	25.6
Calcium Sulphate,	58.1	23.3
Magnesium Sulphate,	22.6	2.6
Magnesium Chloride,	11.4	6.0
Sodium Chloride,	30.1	12.3
Alkalinity,	42.7	25.6
Total Solids,	184.2	93.6
Suspended Matter,	4.3	Trace.
Free Carbonic Acid,	3.8	1.9
Ignesting Solids,	154.1	63.4
Non-ignesting Solids,,	30.1	12.3

At Freeport domestic sewage is contributed directly or indirectly by the entire population of about 2,000 persons and industrial wastes of minor importance by the Pennsylvania Distillery Company and the Guckenheimer Distillery. At Millerstown about 1,200 persons contribute sewage pollution. Worthington contributes the sewage of about seventy-five persons and manufactural wastes from the Graff Woolen Mill. These wastes include water from the dye tanks and wool scourings, the plant using about 228,000 pounds of wool annually in the manufacture of blankets. Natrona contributes the sewage of about 2,000 persons and manufactural wastes from the Pennsylvania Salt Manufacturing Company. This plant manufactures sulphuric, muriatic and nitric acids, hydrate of aluminium, sulphate of soda, copperas, and sal-soda. The liquid wastes amount to about 150,000 gallons daily. They contain iron and soda in solution. Brackenridge pollutes the river with the sewage of practically all of its population of 2,500 persons. At Tarentum the sewage of about 7,000, the entire population, pollutes the river, either directly or indirectly. The Pittsburgh Plate Glass Company's Plant discharges into the river industrial wastes that contain some oxide of iron and muriatic acid in solution, and from the Tarentum Paper Mills about 2,000,000 gallons of water daily containing spent solutions of chloride of lime and soda are discharged into the river. At Arnold the river receives the direct or indirect

pollution of about 1,200 of the inhabitants. New Kensington discharges the sewage from practically its entire population of 6,800 into the river. At New Kensington also the "Pittsburgh" Plant of the American Sheet & Tin Plate Company discharges daily about 6,300 gallons of acid liquor from the pickling vats and the "Pennsylvania" plant of the same company discharges similar acid liquor to the river. These acid wastes come from the galvanizing plant where sulphuric and hydrochloric acids are used. At Parnassus, the sewage of about 1,500 persons (nearly three-quarters of the population) pollutes the river, together with manufactural wastes from the National Lead & Oil Company's Plant, amounting to 5,000 gallons a day of waste water containing a trace of lead and some acetic acid. At Springdale, about 1,000 persons (two fifths of the population) discharge sewage into the river. The Pennsylvania Glue Company's Plant here, discharges wastes from a sedimentation tank in which there is an effort made to intercept grease and suspended matter. The effluent is thoroughly impregnated with lime. Cheswick discharges into the river the sewage of about 300 persons. Oakmont, with 3,400 population, has a sewer system serving most of the people. The entire population of Verona, 2,700 persons, is connected with the sewer system which discharges into the river. The Allegheny City Home, and the adjoining institution—the Allegheny County Workhouse—at Claremont, or Warner Station, have erected and are operating sewage disposal works. They treat all the sewage from these two places, which represent about 1,500 persons.

As previously stated, from the thirty-nine coal mines in this division of the basin, there is a total of 5.045 gallons a minute of acid mine drainage discharge into State waters.

The survey of the district, in detail, will be taken up in the following order; Freeport, Millerstown, Worthington, Natrona, Brackenridge, Tarentum, Arnold, New Kensington, Parnassus, Springdale, Cheswick, Oakmont, Verona, and Claremont.

Freeport, Armstrong County, is a borough, with a population of about 2,000, on the west bank of the Allegheny River just below the mouth of the Kiskiminetas River in the extreme southwestern corner of Armstrong County. Buffalo Creek forms the western boundary of the borough, the land along the creek and river being comparatively flat and about fifteen feet above low water, back of which the surface rises to an elevation of about 200 feet higher. The borough has one large industry, the Guckenheimer Distillery, located on an island in the river and giving employment to 165 men. The Pennsylvania Distillery Company also operates a small distillery just west of the borough. The Freeport Milling Company operates a planing mill and flour mill employing about fifteen hands. Water for public use is supplied by the Freeport Water Works Company,

a private corporation taking water from two cribs in the Allegheny River. Under a permit issued by the Commissioner of Health on Sept. 2nd, 1908, a gravity filter plant was installed for the filtration of the entire supply. Owing to the bad condition of the river water, many springs and wells, prior to 1909, supplied a large portion of the drinking water used in the community. The Guckenheimer Distillery takes a private supply from the Allegheny River for boiler purposes and uses water from a series of driven wells for manufacturing purposes, while the Freeport water works supply is used for fire protection. The borough is equipped with a combined sewer system which drains one half of the municipal area. There are five outlets, two into Buffalo Creek and three into the river, beside which there are fourteen or more private sewers. About 1,300 persons are served by these sewers, the remaining population using earth vault privies, of which there are over three hundred in the borough. Many of these are in close proximity to the wells and springs used for drinking water, which together with the use of unpurified river water would readily account for the general prevalence of typhoid in the past. Typhoid records are not thoroughly reliable owing to the failure on the part of the physicians to report cases, but there appear to have been at least from fifteen to thirty cases annually during the past ten years except 1907, during which year twenty-two deaths were recorded, indicating 200 to 300 cases. A permit was issued to the borough by the Commissioner of Health on September 18, 1908, for the construction of certain sewer extensions.

In this sewerage permit of 1908, the following statements were made by the Commissioner of Health:

"The general prevalence of the disease from year to year is evidently due to the pollution of the drinking water of the community. While the water furnished by the water company is highly contaminated by sewage, yet on account of the widespread use of spring and well water in the borough taken from sources which are in proximity to privy vaults and cesspools, such water should be viewed with suspicion also. The water works company contemplates the installation of a high grade filter plant, and plans therefor are now under consideration by the State Department of Health. The construction and operation of this filter plant may not reduce the typhoid fever to a sufficiently low rate owing to the use of the said well and spring waters. Therefore, the borough officials should co-operate by making a rigid inspection of the private water sources in the borough. The existence of so many earth closets is a menace. One remedy is the construction of sewers and compulsory connection therewith. The borough contemplates affording this remedy.

"In addition to the sewers which have been constructed by the borough since April, 1905, and enumerated hereinbefore, the borough purposes to build extensions in the immediate future along streets where paving is to be done. These sewers are planned to carry storm and roof water in addition to the sewage and are to be connected with the existing system. The borough desires to lay three hundred and seventy-five feet of fifteen inch sewer on Sixth Street between Market and High Streets; three hundred and sixty feet of eighteen inch sewer on Washington Street from Fifth to Stewart; four hundred and fifty feet of fifteen inch sewer on Stewart Street from Washington Street north; all of which discharge through the Fifth Street outfall sewer into the Allegheny River. There is also a section of three hundred and seventy-five feet of fifteen inch sewer extending from High Street to Market Street on Third Street and discharging through the First Street outfall sewer into the Allegheny River. The petitioners state that they have advertised for this work in connection with street paving and are anxious to place it in the ground before paving is begun. The total length of the extensions is fifteen hundred and sixty and they will drain twenty additional house connections.

"The borough of Freeport is supplied with water, so it is seen, from the Allegheny River which is polluted with sewage from various towns and boroughs located above the intake. The nearest borough above the Freeport Water Works is Ford City, which is distant only ten miles and whose sewage is discharged into the Allegheny River. The Department of Health has recently granted a permit to Ford City to discharge its sewage and to extend its system only under condition that plans for a separate system of sewers and sewage disposal plant be prepared and submitted to the Department of Health for approval in the immediate future. This policy of the Department has also been carried out in the case of the boroughs of Tarentum, Brackenridge, and Natrona, located immediately below Freeport and contaminating the Allegheny River with sewage. The borough of Freeport should, therefore, expect to co-operate with this policy of the Department in protecting the purity of the water supply of the various municipalities along the Allegheny and Ohio River, more especially since its sewage is discharged into the river at a point six miles above the water works intake at Tarentum by means of which residents of Harrison Township, Brackenridge, and Tarentum boroughs are supplied with drinking water.

"It appears, if reports be true, that the municipal borrowing capacity within the seven per cent. limit of indebtedness is \$12,000, taking into account the present assessed valuation and indebtedness. Therefore, the borough is not in a position to assume the expense of erecting sewage disposal works or to eliminate the storm water from existing sewers. The cost of disposing of sewage mixed with storm and roof water is prohibitive and it will be necessary for the borough to change its sewer system to some extent. It would be better to exclude all roof and storm water and to carry sewage only to the disposal plant, but it may be found that a portion of the roof and street water may be permitted to continue to flow into the sewers after the sewage disposal plant shall have been erected. This is a question of engineering which needs to be carefully studied by some expert employed by the borough, and the State Department of Health will be glad to further advise with respect to such study. It appears that it is necessary that there should be storm sewers in the low district of the borough to avoid washouts from the hillsides. With the existence of two outlets within four hundred feet of each other at Fourth and Fifth Streets, it should be possible at little expense to remodel the system so as to discharge the storm water from one of these outlets and use the other solely for sanitary sewage."

The borough subsequently submitted for approval plans for a sewage disposal works and in a decree relative thereto, issued by the Commissioner of Health on July 11, 1912, the following discussion may be found.

"In carrying out a consistent policy relative to sewerage applying to municipalities throughout the State, the Commissioner of Health, in the permit issued September 18, 1908, required that the borough of Freeport prepare a comprehensive sanitary sewerage plan to cover the entire borough and to provide for the concentration of all the sewage for treatment in suitably designed and located disposal works. With such an approved plan to follow, the borough would then be in a position to construct any or all such sewers as may be desired from time to time without making application for further permits and have assurance that no portions of the system will need to be reconstructed when additional territory shall need to be sewered or when treatment of the sewage shall become necessary. The advantages and economies to be derived from such a comprehensive plan are manifest.

"No comprehensive plan has been submitted and the Department therefore does not know how the sewage is to be concentrated at the proposed site for the disposal works. Moreover, the suitability of the disposal site is open to question since from the evidence at hand it is apparently too close to the settled portions of the borough. The type of plant selected is not suited to the particular needs of the borough of Freeport since a much less expensive plant would doubtless give satisfactory results.

"The services of an expert engineer should be at once secured by the borough to prepare a comprehensive sewerage plan for the entire borough area, including means for collecting all of the sewage contributed by the borough for some years to come and conveying it to a proper site for disposal, and plans for disposal works. The Department will gladly advise with the engineer in the preparation of the comprehensive plans and in selecting the type of disposal works and the site upon which they are to be located, and will lend any assistance in its power to the end that the borough may secure the proper solution of its problem.

"The proposed sewer in Washington Street seems adaptable to such a comprehensive plan and economy dictates that it should be constructed at the present time before the street shall be paved. Under the circumstances approval should be given of the construction of the sewer but permission to connect with and use the sewer should be temporarily withheld."

In the water decree of 1908, the Commissioner of Health had the following things to say:

"The company supplies 500,000 gallons of water per day, of which 300,000 gallons are used for industrial purposes. The railroad company at Freeport Junction is the largest consumer.

"Practically every house in the borough is connected to the water mains and in addition the settlement at Freeport Junction and also that in South Buffalo Township immediately east of the borough are generally supplied by the company.

"The water furnished by company is, however, not used generally for drinking purposes. There is a prejudice against the use of this water due to its being taken directly from the Allegheny River, which is highly polluted, and also to the muddy condition of the water during the flood stages of the river. The people in the borough use several springs which outcrop at various points in the borough between the ridge and the river, and probably a dozen dug wells. These wells range from four to six feet in diameter and go to a depth of thirty feet where the bottom is about on a level with the river bed. The wells are lined with dry rubble field stone.

"The existing water works system consists of a pumping station located on the Allegheny River about three quarters of a mile above the borough proper and one thousand feet from the borough line, in South Buffalo Township; three storage tanks with a total capacity of 250,000 gallons located on the ridge at the eastern edge of the borough immediately on the borough line; and six miles of supply mains ranging in size from three inches to ten inches.

"When the water works were first constructed in 1885 water was taken from the river at a pump station located on the main land near the eastern end of Todd's Island. In 1892 this pump house was abandoned and the existing pump house was constructed.

"Water is taken from the Allegheny River at this pumping station through two wooden cribs located six feet below the river bed and covered with sand and gravel. These cribs are located fifty and one hundred and fifty feet from the river bank, respectively. The crib nearer the bank of the river is fifteen feet by thirty feet by five feet deep and is connected with the pumps by a twelve inch suction line of flanged pipe. The other crib is sixty-five feet by fifteen feet by four and a half feet deep and is connected by an eight inch wrought-iron pipe line. During low water periods the crib nearer the bank is out of service.

"The proposed filtration plant is to be located immediately above the existing storage tanks near the crest of the hill. It is proposed to install these filters in two units each with a capacity of 500,000 gallons and also to construct on top of the crest a settling tank having a capacity of 100,000 gallons. A coagulant pump and chemical mixing apparatus are to be located at the existing pumping station for introducing a coagulant into the force main.

"A by-pass line is provided around the filters, so that the water from the settling basin can be introduced directly into the storage reservoir without passing through the filters. The Greer Filter Company, who have prepared the plans for the filter plant and propose to install the same, have guaranteed a bacterial reduction of not less than 98 per cent. when the bacteria in the unfiltered water are 3,000 or more per c.c., and that when the number is less than 3,000, the average number in the filtered water shall not exceed one hundred per c.c., and shall meet the requirements of the State Board of Health. They propose to furnish with the filter plant a field equipment of testing apparatus and chemicals for making tests of the raw and filtered water and to instruct the operator how to make the necessary tests.

"In order to obtain the full capacity of the storage tanks, a float and valve are to be provided on the smaller tank which will automatically close the inlet when it is full and allow the other two tanks to fill to their full capacity.

"The continued prevalence of typhoid fever at Freeport demands the installation of a proper water purification plant. While there is at present some reduction in the number of bacteria due to infiltration through the cribs at the intake and through subsidence in the storage reservoirs, yet it is absolutely necessary to safeguard the public health of this community that an efficient filter plant should be installed which will be operated in an intelligent and careful manner. It is to be noted that the water works company realizes that this will be a profitable investment, as it will increase the domestic consumption and will probably eliminate the use of the wells and springs which are now in constant use for drinking purposes and are not above suspicion. The water company has voluntarily submitted this application for the approval of a filtration plant and should receive the support of the borough officials in its efforts to furnish a pure supply.

"The facilities for fire protection in a large portion of the borough appear to be inadequate. Through the centre of the borough the hydrants are connected to the six inch supply mains and are sufficiently close together to furnish ample protection in time of fire. In other sections of the borough there are many hydrants connected with three and four inch mains and spaced eight hundred feet apart, so that during a severe fire it would be difficult to supply a sufficient amount of water. It would be advisable to increase the fire protection, either by constructing larger mains in these districts or by installing hydrants at more frequent intervals.

"The plans submitted contemplated the by-passing of raw river water around the filter plant at intervals. As stated above there are three methods of by-passing water around the filters and by one of these it goes directly into the mains without any sedimentation or storage. Such by-passes are a menace to a water supply when the source of supply is contaminated and should be used only in the case of a great emergency. When so used all consumers should be notified in advance and advised to boil their drinking water.

"The plans of the filters as submitted should furnish a plant of the highest type of efficiency, if intelligently operated. It is advisable in the installation of a filtration plant that the expert who installs it shall be entrusted with the general supervision of the plant for at least one year after installation or some one equally competent, in order that he may be fully responsible for the efficiency. It is impossible to allow a plant to be operated by one who is entirely ignorant of filtration without impairing the efficiency. It will probably be necessary to cover the storage reservoirs to prevent growths of algae."

Millerstown (Chicora P. O.), Butler County, is a borough with a population of 1,200, situated at the head waters of Buffalo Creek in the east central part of Butler County. The only industries noted are a grist mill and the Chicora Whip Company, the latter plant employing about twenty persons. Drilled wells owned by H. A. Leopold supply the public with water, there being three wells within the borough limits from which water is pumped to a reservoir. Water is supplied to the B. & O. Railroad from a spring of doubtful character, and is used for the engines, though it is doubtless occasionally used for drinking purposes. There is no public sanitary sewer system, but there are two storm sewers eighteen inches in diameter receiving surface water only. There are also a number of private sewers discharging to Buffalo Creek. Practically the entire population contributes sewage pollution either directly or indirectly.

Worthington, Armstrong County, is a borough with a population of 500, situated on Buffalo Creek about seven miles west of Kittanning. Buffalo Creek flows approximately parallel to the river through the western part of Allegheny County and enters the river at Freeport. The borough of Worthington has but one industry, the woolen mill of Peter Graff & Company, employing fifty hands in the manufacture of wool blankets. They manufacture 38,000 pairs of blankets annually, using 228,000 pounds of wools. The water supply consists of individual wells and springs, the woolen mill using some water from Buffalo Creek for industrial purposes and some from a mountain spring. There is no public sewer system, privies being in general use and kitchen wastes discharging to the ground. There are a few private individual sewers. The industrial wastes from the woolen mills include waste water from dye tanks and from scourings.

Natrona, Harrison Township, Allegheny County, is a village with a population of about 4,500. It is situated on the west bank of the Allegheny River about twenty-four miles from its mouth. It extends along the river to the northern boundary of the borough of Brackenridge. It is an industrial community built up originally

around the works of the Pennsylvania Salt Company, upon which it is chiefly dependent. The other important industries are three plants of the Allegheny Steel Company employing 1,550 men, and the Western Tool and Forge Company near the Brackenridge line with 100 employees. A portion of the village was formerly supplied with water by the Tarentum Water Company, but the greater portion of the population is now served by the newly incorporated Natrona Water Company which derives its supply from a number of springs. Occasional shortage in this supply had led to the installing of a half million gallon mechanical filter whereby river water is purified and used to augment the spring water supply. The Commissioner of Health on December 16, 1908, issued a permit for the use of this filtered supply. A few of the inhabitants still depend on springs for drinking water. The industrial plants have private supplies for drinking purposes (either filtered or spring water) and have private industrial supplies taken from the river. There are a number of sewers in the village, public and private, which receive sewage from probably one half the population discharging it by way of six outlets. These sewers receive also surface drainage and manufacturing wastes from the industrial plants. Plans for municipal sewerage were submitted to the Commissioner of Health and on July 17, 1907, a decree was issued by him withholding approval of the proposed plans and requiring that new plans be prepared providing for the collection and purification of all the sewage of the village. The various companies from whose plants sewage was discharged into the river were notified to provide some other method of disposal, preferably by connection to the proposed township sewerage system and sewage disposal works. At the works of the Pennsylvania Salt Manufacturing Company making sulphuric muriatic, and nitric acid, hydrate of aluminium, copperas, sulphate of soda, and sal-soda, the solid wastes are handled on the premises. Liquid wastes amounting to about 150,000 gallons daily and containing iron and soda in solution are discharged into the river.

The decree of 1907 contained among other things the following statements by the Commissioner of Health:

"The petitioners represent that the proposed plans for a municipal sewer system were adopted in 1903 and it appears from the general plan submitted that the sewers are to range in sizes from ten inches to five feet in diameter, that they are to receive both sewage and storm water and are designed to drain the hillsides and the flats in the built up part of the village from Sycamore Avenue northerly and also to intercept the flow from all existing public and private sewers and culverts in the village north of said Sycamore Street, excepting the Salt Company's four foot sewer and the lower portion of the stone culvert. The point of discharge into the Allegheny River of the proposed system is opposite the foot of Sycamore Street, the outlet being a four by five foot structure carried to low water.

"If the reports are accurate, the assessed valuation of property in the township is \$219,820 only. It is also reported that there is a bonded indebtedness and that the Commissioners have a fund of about \$5,000 in the treasury. Hence, under these conditions, the borrowing capacity is in the neighborhood of \$15,000. Thus

limited by the constitution, the utmost prudence in the expenditure of the public funds is called for to assure the distribution of the benefits of a public sanitary improvement to the greatest number. A general combined sewer system cannot be built for the money now available, but a small pipe system for the reception of sewage only might possibly be built under some equitable plan of sewer assessment, such as is provided by law.

"The proximity of municipalities on the Allegheny River below Natrona, coupled with the fact that at eight different places within seventeen miles, water is drawn from the river and used as a source of public supply, renders the problem of sewage disposal at Natrona one of wide-spread concern relative to public health.

"Some of the places below Natrona supplied with Allegheny River water are as follows:

"Tarentum, distance one and five-tenths miles; New Kensington, three and five-tenths miles; Parnassus, four and five-tenths miles; Oakmont, eleven miles; Verona, thirteen miles; Montrose (Allegheny City intake), thirteen and five-tenths miles; Pennsylvania Water Company, fifteen miles, and Pittsburgh, seventeen miles.

"Strikingly significant are the facts with respect to the prevalence of typhoid fever in the Tarentum Water Company's district. In the borough of Tarentum, which is much larger than the village of Natrona, during 1906, there were 110 cases of typhoid fever reported and for the first five months in 1907, 46 cases. In the borough of Brackenridge, from which reports are very incomplete, the disease is known to have been common. This has not excited local attention probably because typhoid is present the year round.

"During the last part of 1905, typhoid was epidemic in Natrona village, and of 30 cases attended by one physician, twenty-six were on the Tarentum supply and four originated out of town. The same physician attended ten cases during 1906, all in the village and on the Tarentum supply, with one exception. It is said that not a single case of this water borne disease has been traced to or charged against the spring water supplied to the northern half of the village by the Salt Company's system.

"The sewers now existing in the village deliver their pollutions into the river immediately above the point from which the water is drawn out of the river and conveyed to the consumers in the south part of the village to be used for domestic purposes. Hence the township authorities are concerned with respect to the removal of this menace to the township's water supply. Notwithstanding this fact, the proposed plans do not provide for the treatment or purification of the sewage. It is evident that so long as typhoid poison be discharged into the river from Natrona, the health of the general public in the towns down stream using the river waters for drinking purposes will continue to be menaced. The notably high typhoid rates in the Allegheny River valley testify to the consequences of polluting drinking water with sewage. In order that Natrona shall cease to be one of the foci of infection, two things are necessary; first, typhoid should be banished from the village, and second, sewage discharged into the river must be discontinued.

"The banishment will be caused largely by a pure water supply. If the river is to be continued as a source the water must be thoroughly purified by modern and approved apparatus. Meantime, all river water used for domestic purposes should be boiled.

"The discontinuance of the discharge of sewage into the river can be effected by the erection of sewage purification works, by means of which the chances of pathogenic poison being introduced into the waters of the State may be largely minimized, if not wholly obviated. However, it is not practicable, owing to the excessive cost, for a township of Harrison's size to construct works for the treatment of both sewage and storm water. The economies of the case very generally throughout the Commonwealth, where sewage must be treated, require that the conduits in which surface waters are removed shall be separate from the pipes designed for the conveyance of household drainage to the disposal works. Because the proposed sewers are now designed to take both sewage and storm water, they are not adapted to the present or future requirements imposed by the State under the law requiring the preservation of the purity of streams for the protection of the public health.

"Furthermore, no provision is made in the plans for the interception of the sewers at the industrial plants in the township. It would not be consistent to require the village sewage to be treated and permit the sewage from an equally great population resident at the mills and factories during working hours to go into the river. Either the private corporations must take care of their own sewage, or the public corporation must make provision therefor under some equitable adjustment of costs and expenses.

"It appears that the growth of the township and the village will be in the valley on the plateau, and it is reasonable to anticipate the ultimate occupation of all the land there. The selection of a site for sewage purification works, is a most important matter and calls for study, foresight and the laying down at this time of the sanitary policy which shall prevail for the future. The time has arrived for the adoption of a comprehensive sewerage plan and the township commissioners need the services of a competent and experienced engineer to devise comprehensive sewerage and sewage disposal plans. These should be submitted to the Commissioner of Health for approval.

"In view of all the circumstances, it has been unanimously agreed by the Governor, Attorney General and the Commissioner of Health, that the interests of the public health demand that the Commissioner of Health withhold a permit and I do hereby and herein withhold a permit to the township of Harrison to construct the proposed sewer system and advise that it will be necessary for the Commissioners of said township to prepare new plans for the collection of all sewage of the village of Natrona and for its conveyance to some point for treatment and purification. The plans for sewerage and sewage disposal should be comprehensive and be designed in anticipation of future as well as present needs. Storm water should be excluded from the sewers, separate conduits being provided for drainage. Upon preparation of the new designs, which should be by some experienced engineer, such designs should be submitted to the Commissioner of Health for consideration.

"It has also been unanimously agreed that the Township Commissioners should be requested and I do hereby and herein request the Harrison Township Commissioner to notify the public in said township to boil all river water used for domestic purposes.

"The Commissioner of Health will notify the various private companies in Harrison Township from whose plants sewage is now discharged into the Allegheny River, that some other method of disposal than into the river must be provided, preferably by connection to the township sewerage system and sewage disposal works when such are available."

The water decree of December 1908, approving the installation of a mechanical filter plant contained the following statements by the Commissioner of Health:

"The Natrona Water Company is chartered to supply spring water to the public in the township of Harrison and has no right, under its existing charter, to furnish an additional supply of filtered river water. Steps should be taken immediately to obtain an extension of its charter rights which will permit it to use this additional supply and the Water Supply Commission should be consulted in regard to this matter.

"In using the river supply of water for domestic purposes, which is rendered necessary on account of the limited quantity of spring water, there is a danger of spreading typhoid and other water-borne diseases due to carelessness in the use of this auxilliary supply. The Natrona Water Company appreciates this condition of affairs and on that account has voluntarily submitted the plans for the filter plant to be installed for purifying this supply and eliminating this danger.

"The filter plant as submitted is equipped with all modern appliances and, if carefully operated, should prove efficient. There are some details in connection with it which have not been provided for in the plans submitted, but which will be necessary to completely equip the plant. The outlets from the filters are provided with orifice controls which will limit the rate of filtration below the maximum allowable rate, but no provision is made for cutting off the supply from the filter when the small clearwater well is full. This can easily be arranged by supplying a control float valve at the outlets. The troughs in the filters are located at an elevation of only eight inches above the top of the sand in the filters. It is the general practice to make the minimum height over the top of the sand to the trough fifteen inches and in many cases where wash water alone is depended upon for agitation and cleansing the filter this distance is increased to a greater depth. The William B. Scaife & Sons Company, who have submitted plans for these filters, claim that this is unnecessary in their filters due to the special arrangement in their nozzles whereby the washing water is forced out horizontally through the gravel and there is a uniform distribution over the whole filter area. However, it appears that it would be more advisable to raise these troughs to a minimum height of fifteen inches above the filter surface.

"The plans do not show in what manner the wash water and other waste water from the filter plant will be disposed of. In constructing the plant, special attention should be paid to protecting adjacent property from this waste water. The valve provided between the water company's mains and the pressure lines belonging to the Pennsylvania Salt Manufacturing Company for fire protection should only be opened in extreme emergencies, when the fire is sufficiently developed to require this additional supply. The mains, after being filled with raw water from this source, should be thoroughly flushed.

"The spring water supply furnished for drinking purposes appears to be satisfactory and the springs appear to be well protected from pollution. It is stated that in typhoid fever epidemics in this locality very few cases have been traced to the water supply from this company."

Brackenridge borough, Allegheny County, is a rapidly growing, community of about 2,500 inhabitants located on the west bank of the Allegheny River immediately above Tarentum borough and be-

low the village of Natrona about twenty miles above Pittsburgh. The industries within the borough territory are the Tarentum Glass Company employing 200 hands, the Fidelity Glass Company employing 350 hands, and the Anchor Brewing Company. The Flaccus Glass Company just inside Tarentum is also industrially important in Brackenridge. Public water is furnished by the Tarentum Water Company operated by the Allegheny Valley Water Company deriving its supply from an intake crib in the river opposite the central part of the borough. On Sept. 6th, 1907, the Commissioner of Health approved plans for a filtration plant and ordered the same to be erected. Previous to the installation of this purification plant typhoid fever had been endemic in the territory supplied by the Tarentum Water Company. From January, 1905, to August 1, 1907, there were 175 cases of typhoid fever in Brackenridge, all of which may not have been due to the infection of the public water supply as private wells and back yards pumps are in common use.

This permit of 1907 contained the following statements made by the Commissioner of Health.

"The borough of Tarentum is located on the west bank of the Allegheny River in the northeastern part of Allegheny County about twenty-one miles above Allegheny City, and on the West Penn Division of the Pennsylvania Railroad system. It is bounded on the north by Harrison Township and the borough of Brackenridge, recently incorporated out of said township, and on the west and south by East Deer Township, said township extending along the river for two miles below Tarentum, the villages of Creighton, Hites and Glassmere being located on the railroad on the bank of the river in this township.

"Above Brackenridge, in Harrison Township, is the large village of Natrona. These places are all supplied by the Tarentum Water Company.

"The Tarentum water works system comprises a filtering crib in the river, intake well, pumping plant, force main, subsidence storage basin, gravity supply main, and distributing pipes.

"The intake, pumping station and reservoir are located in the borough of Brackenridge.

"In the water district there is a total population of 12,080, the actual consumers numbering 10,655. The population using the public supply in Harrison Township, including Brackenridge borough, is 2,385. In Tarentum borough 7,490, and in East Deer Township, 780. It is estimated that the consumption averages 2,125,000 gallons daily of which 2,000,000 are used for domestic purposes. This larger per capita rate is attributable to waste on account of the poor quality of the water. Many of the householders keeping the faucets open and the water running continuously. The water is often muddy and always polluted by sewage. The sewers of Natrona village discharge into the river at a point a little over a mile above the filter crib and intake well. The sewage from industrial plants and from a large population is also discharged into the river above the Tarentum intake at many places. Physicians and health officers have urged the borough consumers to use filtered and boiled water. Notwithstanding this advice which is carried out to some extent, typhoid fever is prevalent as would be expected under the circumstances.

"The Department has had a canvass made of the district, physicians' records have been examined and it appears that up to August 1st, of the current year beginning January 1st, 1905, that there has been a total of 578 cases and 31 deaths.

"These figures are largely in excess of the cases reported by the local physicians and returned to the Department by the local registrar. The distribution of the cases among the water consumers total 34 for East Deer Township, 290 for Tarentum, 157 for Brackenridge and 97 for Harrison Township. It appears for 1905, that there were 102 cases in all, and for 1906, 292 cases and for 1907, 184 cases in the district. During 1905, in Natrona, out of 30 cases attended by one physician, 26 were on the Tarentum supply, and the same physician attended ten cases in 1906 in the same village on the same supply. It is reported that the portion of Natrona supplied by the Salt Manufacturing Company's system of water works has been free from the disease in those families supplied exclusively by this water, which supply is obtained from springs located on the hillsides and protected from pollution.

"On July 24th, 1907, the Commissioner of Health notified the Tarentum Water Company that its source of supply is prejudicial to public health and requested said company to submit a plan for the filtration of the water to the State Department of Health at as early a date as possible.

"An agreement has been made between the Roberts Manufacturing Company of Philadelphia and the Tarentum Water Company's Works, whereby the said manufacturing company is to erect within a building and upon foundations to be furnished by the purchaser, a gravity filtration plant to be located on the hill contiguous to the Tarentum Water Company's reservoir, and to consist of three coagulating or subsidence tanks and six mechanical filter units with all necessary appliances and appurtenances and guarantees that the filtered water shall be bright and clear and practically free from suspended matters, turbidity and discoloration, and that the filtration plant shall be capable of delivering three million gallons of water each 24 hours, and that when the number of bacteria in the raw water is 3,000 or more per cubic centimeter, there shall be a bacterial reduction in the filtered water averaging not less than 98 per cent., as determined by an examination of not less than 30 samples collected from the filtered water collecting flume in a period of not less than 15 days; and that when the number of bacteria in the raw water is less than 3,000 per cubic centimeter, the filtered water shall show an average of not more than 100 per cubic centimeter as determined by similar examinations, which guarantees are made subject to the condition that the purchaser will operate the plant properly and according to instructions, that a suitable quantity of coagulant shall be used, that the guaranteed capacity of the plant shall not be exceeded and that the filters and coagulating tanks shall be cleaned as frequently as the condition of the raw or applied water may necessitate.

"The water is to be drawn from the Allegheny River through the existing apparatus and to be delivered into the proposed coagulating tanks at the reservoir by the existing pumping engines and force mains.

"If carefully and intelligently operated, the plant should give a fairly good effluent especially under ordinary conditions of river water. But the operation must be carefully attended to. Best design would require that from six to eight hours be provided for sedimentation. Probably more subsidence than now proposed will be proven desirable by experience, and additions may have to be made in the near future. More especially since the settling tanks have two hours' capacity only at the nominal rate of the plant, should a different method of coagulant feed be installed than now proposed. Preferably the chemical should be introduced at the pumping plant to effect a more thorough mixing and preparation for subsidence. And all of the water should be pumped to and pass through the filter plant to the storage reservoir before being supplied to the consumers. The changes in the quality of the Allegheny River are sudden at times, and the amount of chemical solution should be correspondingly changed. If the apparatus were at the pumping station, it might not be necessary, except during prolonged periods of high turbidities when the worst water was being delivered raw to the filtration plant, that an attendant would be required at the purification plant in the night time. Otherwise, such attendance might be necessary.

"The general layout is an attempt to secure an efficient plant at a minimum cost for installation. It will be expensive to operate and maintain. The petitioners have a project for the construction of a new subsidence basin or reservoir on a hill further back from the river to be used for primary sedimentation, so it is reported. Such subsidence cannot be afforded at this time for lack of money to meet the expense, so it appears. Therefore, the operating costs of the proposed filter plant will be relatively high until facilities for more thorough primary treatment of the raw water is afforded."

At the Tarentum and the Fidelity Glass works private spring water supplies are used for drinking purposes. The brewing company also has a private pipe line from a spring on the hill. Outdoor privies and the presence of sink water in the street gutters are noticeable throughout practically the entire borough and nearly all of the dwellings along the river front have private drains directly to the river both above and below the water works intake. The borough has an extensive sewer system with a thirty-six inch outlet near the Tarentum borough line, which sewers receive roof drainage as well as sanitary sewage and serve a large portion of the population. On May 25, 1908, and subsequently on November 19th, 1908, the Commissioner of Health issued decrees to the borough withholding ap-

proval of sewerage plans submitted and urging the advisability of co-operation between the boroughs of Tarentum and Brackenridge and the village of Natrona in the matter of sewage purification.

Excerpts from these decrees are as follows:

(May 25, 1908.) "The contemplated extensions aggregate 2.42 miles which is within one-third of a mile of the length of the sewers now built. The extensions are to be divided as follows: 2,270 feet of 24 inch, 320 feet of 18 inch, 2,870 feet of 15 inch and 7,326 feet of 12 inch.

"With the exception of Brackenridge Avenue no highway in the town has its surface permanently paved. The petitioners are seriously considering the paving question. It should, however, not be given precedence over the higher duty of disposing of the sewage in a safe and sanitary manner. Not only do the interests of the public health in Brackenridge demand that sewage from Natrona and other upstream municipalities and places shall be purified and rendered harmless before reaching the river, but they demand, together with the same interests elsewhere in the valley, that Brackenridge sewage shall be purified. It is reported that the municipal assessed valuation is in the neighborhood of \$1,000,000, and that its borrowing capacity, taking into account its present bonded indebtedness, is in excess of \$50,000, which, if true, enables the municipality to give serious consideration to the means by which sewage treatment shall be accomplished.

"Natrona has been denied the right to extend its sewer system and discharge sewage into the river. The State Department of Health has called for plans for a purification plant. There is no well defined line between Brackenridge and Tarentum, in fact all these places form one continuous settlement and it is probable that a competent expert could develop sewage disposal works for these settlements under some joint co-operative plan which would prove financially advantageous to each. One thing is certain, the treatment of sewage mingled with storm water would prove prohibitive in cost. There must be a separation. At the present time most of Brackenridge sewers as shown above take the place of natural water courses and are essential for storm drainage. It would be inconsistent for the State to approve of a sewerage plan whose consummation did not bring about the collection of the entire borough's sewage and its deliverance to some point for purification. It is not made plain to the Department why the proposed sewer on the flat should not be for sanitary purposes only and why all of the lateral sewers proposed should not be strictly for sanitary purposes. It is an extravagant and improvident thing for the borough to jump hastily to the conclusion that economy and efficiency will be achieved by the laying of combined sewers from now on. It is a natural conclusion, however, since the main storm drains have been laid and they are at this moment convenient outlets for the sewage; but in view of the fact that the Allegheny River and the Ohio are now and must continue to be the sources of public water supply to the inhabitants along their banks, and in view of the fact that it has become a State policy to preserve the purity of the waters of the State for the protection of the public health, the borough should very carefully study how best to collect the sewage from all parts of its territory and convey it to a place for treatment. In this study existing sewers may be incorporated to some degree if found practicable, but the lateral and new sewers should exclude surface water. Finally when the plan shall have been worked out and adopted and made official by approval of the State Department of Health, the borough can build a sewer in any particular street whenever it may see fit to do so, with the assurance that the plan is a permanent one, and that it will be economical and efficient and best protect and subserve the interests of all concerned.

"In view of the fact that the borough of Brackenridge has extended its sewer system contrary to the provisions of law, and in view of the fact that it did not take advantage of the exemption clause of Act 182 of 1905, its sewage is being illegally discharged into the waters of the State; and in view of the further fact that the speedy removal of sewage from the vicinity of dwellings in a system of underground pipes should be a means of promoting public health in the borough and elsewhere if the sewage be properly disposed of, therefore, it has been unanimously agreed by the Governor, Attorney General and Commissioner of Health, that the interests of the public health demand that a permit be withheld and that the borough of Brackenridge be notified that it must on or before August 1st, 1908, prepare a comprehensive plan for the collection and purification of the sewage of the borough, to include not only those districts which are now sewered into the river, but all of the municipal territory having its natural drainage into the river, which plans shall be submitted to the Commissioner of Health for approval, on or before said date.

"The attention of the local authorities is especially called to the advisability and advantages of co-operating with the proper local authorities of Natrona and Tarentum in the study of plans for the treatment of the sewage.

"A hearing should be given to the authorities of these places in order that there shall be a better understanding relative to the requirements of the Commissioner of Health."

(November 19, 1908.) "On October 13th, of the current year, the solicitor of Tarentum borough informed the Department that he was advised that the township of Harrison in which is located the village of Natrona has declined to enter into a joint sewerage plan, but that the borough of Tarentum had directed its engineer to prepare a plan of sewerage and sewage disposal and further, that Tarentum borough will be willing to cooperate with Brackenridge and Harrison Township if the State Department of Health deems it wise so to do and can arrange such co-operation.

"The site of the proposed disposal works is on the river front near the Tarentum borough line and within one thousand feet of Morgan Street and South Canal Street and the railroad. In this territory there are a large number of dwellings and some business blocks. Also Brackenridge Avenue, a main thoroughfare.

"Leading to the site two main sanitary sewers are proposed each twenty-four inches in diameter. One of them is to extend easterly in the alley back of Brackenridge Avenue and it will serve the greater part of the flats and a considerable portion of the hillside district north of the railroad. A new sanitary sewer is to be provided for every street or for alleys back of the streets, and all of the sewage in the district is to be ultimately collected in the district and discharged into the sewage disposal works.

"The site of the disposal works cannot be approved. The odor from it would be sure to create a nuisance to the injury of public health on the flats. A more remote site must be found. It is not prudent to build sewage works nearer than a thousand feet from a dwelling or from property likely to be used for residential purposes.

"Since the sewers are designed to flow by gravity to the disposal works, this necessitates the filling in of Stieren Street to a depth of six feet.

"The sewer grades should be adjusted to the official grades of the highways of the borough in order that abutting properties may obtain adequate benefits from the sewer. If grades are not established, they should be. It would be folly to undertake the laying of permanent sewers without this precaution. There is no place in the borough where a sewage disposal plant can be erected and maintained satisfactorily and from information now at hand in the Department, it seems evident that a proper site for purification works for Brackenridge sewage would be at some distance beyond the borough. Pumping of the sewage to this site must be resorted to for at least that portion of Brackenridge sewage produced on the flats. The hillside sewage may be delivered by gravity. The grades of the proposed sewers should be determined with a view of delivering the sewage in an economical manner to such satisfactory site and purification works.

"It may be emphasized that Brackenridge borough's financial interests are centered very materially about the proposition of a joint sewerage intercepting project and disposal works involving Tarentum borough. If a joint project cannot be consummated, then each municipality must proceed independently but certain it is that efforts should be made by the municipalities concerned to come together on the subject."

The borough of Brackenridge joined with Tarentum borough in preparing plans for a joint sewage disposal plant and they were submitted by the borough of Tarentum. Brackenridge then followed up these plans by plans of its own for the sanitary sewer system to be built within its own territory and on November 9th, 1909, in a decree approving this sanitary sewer system in general, the following statements were made by the Commissioner of Health.

"It appears that the borough of Brackenridge on October 24, 1907, made application for permission to extend the sewers and to discharge sewage therefrom into the Allegheny River. In response to this application, on May 25, 1908, the Commissioner of Health issued a decree hereinbefore quoted. In response to this decree on September 25, 1908, the engineer of Brackenridge borough submitted on behalf of the borough a plan of sewerage on which was located a site for a proposed disposal works. The plans submitted involved the construction of a sanitary sewerage system consisting of sanitary sewers ranging in diameter from nine inches to twenty-four inches and extending throughout the developed section of the borough. Profiles of the sewers were not submitted. The sewers were to drain to the site for the proposed disposal works which was located on the river front near the Tarentum borough line and within a thousand feet of Morgan Street, South Canal Street and the Railroad. In this territory there are a large number of dwellings and some business blocks. It was proposed to construct a portion of the sanitary sewerage system and to drain it temporarily into the existing

storm sewer and eventually to construct the disposal works and eliminate all sewage from the storm sewer. These plans were considered by the Department of Health and on November 19, 1908, a second decree was issued, as hereinbefore quoted. In accordance with the terms of this decree the borough of Brackenridge has submitted the plans for the sanitary sewerage system to be used in conjunction with Tarentum and the joint sewage disposal plant.

"The proposed sewers for which a plan has been submitted, will consist of an entirely new system of sanitary sewers so designed as to drain the entire borough territory. The sewage will be drained through two main fifteen inch sewers which will drain the high district north of the railroad, consisting of the residential section, and the low district between the railroad and the river, consisting of the built up section, respectively. These two fifteen inch main sewers will connect at the southwest corner of the borough with the proposed twenty-four inch joint intercepting sewer to be constructed by Tarentum and Brackenridge boroughs and extending from the southwest corner of Brackenridge borough westerly along the river front to Tarentum borough to the proposed site for the pumping station. At this pumping station the sewage will be lifted to the proposed disposal plant to be constructed by Tarentum and Brackenridge boroughs and for which a permit was issued to Tarentum borough on October eleventh.

"According to the plans submitted, all of the sewage of Brackenridge borough will be collected in this main intercepting sewer and pumped to the disposal plant with the exception of an eight inch lateral on School Alley in the northwestern portion of Brackenridge borough. This lateral is 400 feet long and drains into the high level system of Tarentum borough, which will flow by gravity to the proposed disposal plant.

"In providing to dispose of the sewage by means of a joint disposal plant to be built in conjunction with the borough of Tarentum and in submitting of a plan for a strictly sanitary sewerage system for the collection of the sewage, the borough of Brackenridge has adopted the most economical and satisfactory method of handling the sewage of the borough. This is in accordance with the outline given in the decrees which have been issued to this borough in regard to the proper treatment of its sewage.

"There are many details, however, in the arrangement of the sewerage system which will need revision before the construction of the sewers is begun. The plan for the sewerage system as submitted is poorly designed and can serve as little more than an outline for the final plans for the sewers.

"The plans of the sewage disposal plant submitted by the borough of Tarentum on behalf of Brackenridge borough and Tarentum borough, and approved by the Department of Health in said decree of October 11, 1909, called for a subsidence tank, sprinkling filters and a re-settling tank with facilities for the handling of the sludge. The works are to be located in the township immediately north of Tarentum borough and on the west bank of Bull Creek. The estimated cost of the pumping station, force main and disposal plant for the treatment of the sewages of both municipalities is from \$70,000 to \$100,000.

"In view of the foregoing circumstances, it has been determined that the interests of the public health will be subserved by approving the general plan of sewerage for the borough of Brackenridge as submitted, that is, the general plan to construct a sanitary sewerage system and to purify its sewage before discharging it into the Allegheny River by means of the proposed joint disposal plant to be built and maintained by the boroughs of Tarentum and Brackenridge, as more particularly outlined so far as the sewage treatment plant is concerned, in the permit issued on the 11th day of October, 1909, by the Department of Health to the borough of Tarentum and the same is hereby and herein approved and a permit issued therefor."

Tarentum Borough, Allegheny County, has a population of about 7,000 and is located on the west bank of the Allegheny River about twenty-one miles above the mouth of the river. It is a manufacturing town bounded on the north by Brackenridge Borough, above which lies Natrona Village, the three towns forming practically one community. There are three extensive industrial plants in Tarentum, two of which are at the southern end of the town—the Tarentum Paper Mills employing 150 men and the Pittsburgh Plate Glass Company employing about 500—the third being the Flaccus Glass Company located near the Brackenridge Borough line and employing from 300 to 400 men. The public water supply is furnished by the Tarentum Water Company operated by the Allegheny Valley Water Company whose supply is derived from the river at Brackenridge.

A filtration plant for the purification of the supply was ordered by the Commissioner of Health and erected under a permit issued by him on September 6, 1907, as already fully set forth in the discussion under Brackenridge Borough. The prevalence of typhoid fever of which there were 290 cases in Tarentum between January 1, 1905 and August 1, 1907, pointed out the necessity for this step. The Flaccus Glass Company maintains an intake pumping station for river water for industrial purposes. It is a few hundred feet below the outfall of the main Brackenridge sewer. Drinking water for employees is taken from a driven well. The public sewers of the borough are built on the combined plan and consist of 9.5 miles of sewers of which 7.5 miles have a diameter of fifteen inches or under. There are six outlets; one twenty inches and five thirty inches in diameter. The first decree relative to sewerage was issued by the Commissioner of Health to the borough on May 26, 1908. It approved the construction of certain sewers and withheld approval of others. Industrial wastes flow from the Pittsburgh Plate Glass Company plant through a twenty-four and an eight inch pipe into the river, and contain some oxide of iron and muriatic acid in solution. From the Tarentum Paper Mills about 2,000,000 gallons of water containing spent solutions of chloride of lime and soda are discharged daily into the river through a twenty-four inch and an eighteen inch pipe.

In this sewerage decree of May 1908, the following statements were made by the Commissioner of Health:

"The public supply is furnished by the Tarentum Water Company operated by the Allegheny Water Company and the district comprises the boroughs of Tarentum and Brackenridge and the villages in Harrison and East Deer Townships. The pumping station is located on the river bank in the central part of Brackenridge. Formerly the water was pumped from the river to a reservoir at the summit of the hill, from whence it flowed by gravity to the consumer. Typhoid fever cases were numerous and in 1907 the Commissioner of Health notified the company that its supply was prejudicial to public health and that the water must be filtered. Plans for a mechanical filter plant were submitted and on September 6, 1907, they were approved and the purification plant has been erected. The sewers of Natrona village discharge into the river at a point a little over a mile above the water company's intake. Sewage from industrial plants in Harrison Township also discharges into the Allegheny River above said intake. The physicians and health officers have urged the consumers to boil the water; but this was not generally done. Even now with a filtered supply assured, the menace exists because a filter plant is not germ proof and is liable to a breakdown, in which event the sewage polluted water might be introduced into the homes of the water consumers.

"From January 1, 1905, to August 1, 1907, there were known to have occurred 578 cases of typhoid fever in the water district, of which 290 were in Tarentum. During the first seven months of 1907, there were 86 cases in the borough. As the disease is largely a waterborne one, and the public supply was known to be dangerous the conclusion must be that the larger percentage of cases originated primarily from the poisoned public water.

"The petitioners have submitted a blanket application which provides for sewers in practically all unsewered districts of the town and in general the conditions in these districts are unsanitary. First Avenue, which is the highway in the north and along the river front, does not now have a sewer in it. There are many dwellings thereon having individual sewers to the river. The borough purposes to lay an eight inch sewer in this street. The outlets will be into the existing river outfalls.

"The petitioners are desirous of paving East Eighth Street and wish to lay an eight inch sewer therein and the connecting sewer in Main Street. The work of sewerage the other streets, as indicated on the plans, is to be done from time to time as necessity may demand it. Extensions comprise a total of 11,696 feet of eight inch, 290 feet of ten inch, and 1,365 feet of twelve inch pipe.

"If reports be true, the municipal borrowing capacity is in the neighborhood of \$100,000. So Tarentum is in a position to take up the question of discontinuing the discharge of sewage into the river. This stream is the permanent source of supply of water to the public in a populous and growing district. The interests of the public health demand, and the General Assembly has declared it to be the policy of the Commonwealth, to bring about the preservation of the purity of the waters of the State for the protection of the public health. It is essential that the State authorities should approve only such sewerage plans as contemplate this end. It would not be feasible for Tarentum to assume the expense of treating and purifying mingled sewage and storm water. It is the poisons from the human body which infect the public waters and make them dangerous to drink. It is reasonable when these poisons are conveyed away from the premises in pipes carrying waste water used in the household only, to handle the volume of water in purification works. Fortunately, the present sewer system of the borough can be revised and arranged to exclude the greater part of the storm water, and a comprehensive plan for a practicable separation of sewage and storm water and the incorporation of as many existing sewers as feasible into the improved sewerage system should be worked up at once, together with the plans for the treatment of the sewage. After such a plan shall have been approved and adopted, the borough may then, with prudence and economy, build a sewer in any street in conformity with this plan with the assurance that the work is being permanently done.

"There is no visible evidence of a boundary between Tarentum and Brackenridge. The latter borough wishes to extend its sewers. The village of Natrona has been denied a right to extend sewers and to discharge the sewage into the Allegheny River; but plans for a purification plant have been called for. Undoubtedly a joint intercepting sewer and sewage disposal plant for the three communities would be financially advantageous to each and the authorities of Tarentum might well give this suggestion careful consideration.

"Within the borough the possible pollution of existing domestic supplies of water should be looked into and wells or springs liable to contamination should be abandoned or the menace removed, if this be possible.

"Not only have the sewers been extended illegally, but the local authorities did not avail themselves of the exemption clause of Act 182 of 1905, in consequence of which the borough is privileged to pay the penalty for rendering impure and prejudicial to public health a stream used immediately below as a source of drinking water by hundreds of thousands of people. It is not to be supposed that an enlightened municipality would elect to continue so detrimental a practice if ways and means be at hand whereby a change may be effected to the satisfaction of all concerned; but to arrive at a wise conclusion, plans and estimates of cost are the first requisites. The laying down of sewers in advance of street paving is good business policy and such plans warrant approval. It does not appear, however, that elsewhere in the borough the demands are so pressing as to overbalance the broader considerations of public health."

On July 16, 1909, Tarentum filed with the Commissioner of Health plans for a comprehensive system of sewage and sewage disposal and thereupon the Commissioner of Health issued a permit, October 11, 1909, by the terms of which permit the borough of Tarentum was given permission to discharge sewage into Bull Creek and the Allegheny River until the first day of July 1911, upon the condition that it shall erect and have completed by that date the sewage disposal plant as described in the permit. The borough went ahead and made the sewer extensions authorized by the permit, but the borough neglected to build the sewage disposal plant and at the conclusion of the year 1912, it had not built the plant nor made any physical preparation for carrying out the plans agreed upon in the permit. On the 27th day of June 1912, the Commonwealth of Pennsylvania, entered suit in the Court of Common Pleas of Dauphin County, for the recovery of penalties incurred for the violation of the Act of April 22nd 1905, for the construction of sewers and for illegal discharge of sewage into State waters.

During 1911, an outbreak of typhoid fever quite widely distributed, occurred in Tarentum and Brackenridge among the consumers of the Allegheny Valley Water Company following the use of raw river water by the company as a temporary supply.

During July of 1912, typhoid fever again broke out and the Department, as in the previous year, sent representatives of the Engineering Division to find the cause and protect the water supplies. The management of the water works system has been very unsatisfactory to the people. On June 16th, 1908, at an election the citizens authorized an increase in the indebtedness of the municipality in the sum of \$100,000 for the purpose of erecting a municipal water works system. The water company endeavored to enjoin the issuance of said bonds, but lost the case. On January 4th, 1912, the borough made application to the Commissioner of Health for permission to construct the system. On June 18th, the Commissioner of Health refused such permit until the borough should obtain satisfactory and sufficient proof that its intended source of water supply from drilled wells was sufficient in quantity and quality for the needs of the public. In spite of this and without a permit, the borough purchased a tract of land for the wells and pumping station and another tract of land for the reservoir, and then subsequently the borough contracted for the drilling of wells and paid out considerable sums of money therefor, and in June the borough entered into a contract for the construction of water mains in the streets. And, therefore, on the 29th day of July 1912, the Commissioner of Health issued a further decree refusing to approve any part of the system until the information required in the former decree was forthcoming. Soon after the borough demonstrated that it had made a mistake, that the money expended for the land and the wells had been wasted, because pure water could not be secured in sufficient quantity, or even remotely approximating a quantity sufficient to supply the needs of the borough, and, hence, the State, at the close of the year 1912, had prepared to restrain the borough from further proceeding with the erection of a municipal water plant without a permit, and it will endeavor to show that the bond issue of \$100,000 is illegal and void, as contravening the constitutional power of Tarentum borough to borrow money. The Department insists that the borough must proceed at once to erect and put in operation a municipal sewage disposal plant, and then, if there be money enough, the borough may proceed to construct a proper and approved municipal water works system.

Arnold borough, Westmoreland County, with a population of 2,000, lies on the east bank of the Allegheny River about twenty miles above the river's mouth, and has for its southern boundary New Kensington. Below and adjoining New Kensington is the bor-

ough of Parnassus—the three towns forming practically one community. The plant of the American Window Glass Company is the dominant industry, covering perhaps fourteen acres and giving employment to about 1,000 persons, who reside in the neighboring boroughs. Other industries are the New Kensington Lumber Company, employing about thirty persons, the Peerless Laundry, with about fifteen employees, and the Harold Foundry and Machine Company, with about twenty-five employees. The latter plant is partially in the borough of New Kensington. The public water supply of Arnold and of New Kensington and Parnassus is furnished by the Kensington Water Company and is obtained from filter cribs buried in the bed of the river about 200 feet from shore and about 1,000 feet upstream beyond the borough of Arnold. Water is pumped direct to the consumers of Arnold. A ten million gallon reservoir, concrete-lined, furnishes storage and sedimentation during about three days in the week, when the pumps are shut down. The filter cribs do not afford ample purification. In fact, the water in the mains is at times quite turbid and, presumably as a consequence, typhoid is endemic. In the borough of Arnold, a house to house canvass by an officer of the Engineering Division of the Department, undertaken because of the failure of local physicians to report cases, revealed the fact that there were at least twenty-one cases in the year 1907 and five cases during the first two months of the year 1908. There were probably other cases unreported.

The Commissioner of Health issued an order requiring the water company to install a filter plant. On April 2nd, 1912, the plans for a modern mechanical filtration plant were submitted for approval and they were approved and a permit was issued April 15, 1912. The work of construction has been going on and at the close of the year 1912, the filter plant was practically ready for operation.

Arnold is building a public sewer system. There are several private sewers with numerous connections and there are many individual private sewers. Probably 1,200 persons in this borough pollute the river with sewage. The American Window Glass Company's plant has three sewers taking sewage, roof and surface drainage, and industrial wastes to the river. On January 26th, 1911 the borough made application for approval of plans for a system of sewerage and sewage disposal works. The Department suggested changes in the plans. The borough went ahead and completed the sewers conforming substantially to the suggestions made but without a written permit. The plans called for a trunk sewer down through New Kensington and Parnassus borough to a pumping station and for a force main to the site of the disposal works beyond Parnassus Borough up the valley of Pucketos Creek in Lower Burrell Township. While the application of January 1911 asked for permission to discharge untreated sewage into the Allegheny River within

the limits of the borough, the plans did not show how or where this was to be done. The borough at the close of 1912, is discharging some sewage from the new sanitary sewers into an old storm drain that empties into the river. The borough stands ready to join with New Kensington and Parnassus in a project to build and operate the trunk sewer and disposal works.

New Kensington borough, Westmoreland County, with a population of 6,800, is about nineteen miles above Pittsburgh on the east bank of the river between Arnold borough on the north and Parnassus borough on the south, forming with these boroughs a single community. It is essentially an industrial town, its industries comprising the Pittsburgh plant and the Pennsylvania plant of the American Sheet and Tin Plate Company, each employing in the neighborhood of 500 men; the Union Spring Manufacturing Company, employing 70 men; a plant of the Aluminum Company of America, 600 hands, and the Commercial Box Company employing about 50 hands. The water is supplied by the Kensington Water Company described under Arnold. Water is pumped from the river cribs direct to the consumers in Arnold and New Kensington on four days a week during which time the 10,000,000 gallon reservoir is also filled. This reservoir supplies Parnassus continually, and Arnold and New Kensington during the three days a week when the pumps are not in operation. The partial clarification afforded by the filter cribs and the subsidence obtained in the reservoir are not sufficient to produce a safe supply and the new mechanical filtration plant, built during the year 1912, is practically ready for operation. The prevalence of typhoid in New Kensington has doubtless been due in a large measure to the character of the public water. In 1905 there were in ten cases, in 1906 there were thirty-six cases, and in 1907 there were thirty cases in the borough of New Kensington. In the absence of reliable records, these figures were obtained from a house to house canvass made by an officer of the Department. At the Pittsburgh Plant of the American Sheet and Tin Plate Company, public water is used for manufacturing purposes to the extent of about 323,000 gallons a day, although a pump on the river bank is kept for emergency purposes. Drinking water is supplied from a private deep well on the premises. At the Pennsylvania plant of this company there is maintained a private industrial system deriving from a crib in the river about 12,000,000 gallons a day. This water is largely used for cooling purposes, while a driven well supplies drinking water. The Union Spring and Manufacturing Company has a deep well supply for drinking water and an industrial supply from the river for cooling and hydraulic purposes. The Aluminum Company uses the public water but has a private filtration plant that furnishes water to the men to drink.

New Kensington has a combined system of sewers discharging through five twenty-four inch outlets to the river. There are about eight miles of sewers in the system. Besides these public sewers, there are numerous private sewers from the industrial plants. The entire population may be considered to contribute sewage to the river. The Commissioner of Health on June 26, 1908, issued decrees substantially alike to the boroughs of New Kensington and Parnassus, urging the preparation of comprehensive sewerage and sewage disposal plans and advising co-operation in the matter of disposal by the three boroughs, including Arnold. In the New Kensington decree the following statements were made by the Commissioner of Health:

"On October 23rd, 1907, a citizen of New Kensington made application for permission to extend the borough sewer system into the territory of the adjoining borough of Arnold and to discharge the sewage therefrom through existing sewers into the Allegheny River within the limits of New Kensington. The applicant, it appears, was compelled to seek approval of his plans because neither New Kensington nor Arnold borough authorities would make a formal request for sewer extension.

"North of the city of Pittsburgh, the Allegheny River is bounded on the east bank by rocky, precipitous ridge which rises almost from the water's edge to a height of several hundred feet, there being so little room at the foot of the slope that the railroad of the Buffalo and Allegheny Valley Division of the Pennsylvania Railroad System, which follows up this valley, is located at many places in excavations of solid rock. Wherever the ridge recedes from the river bank sufficiently, there a town has been located. The first settlement is eleven miles above the confluence of the Allegheny and Monongahela Rivers and comprises the boroughs of Verona and Oakmont. The next settlement begins on the east bank of the river six miles above Oakmont and extends for 3.5 miles northerly and comprises in order up stream the boroughs of Parnassus (population 2,200), New Kensington (population 6,800) and Arnold (population 1,600). There is no line on the ground to mark the division of the municipal boundaries, it being all one community to the observer.

"The railroad parallels the river at the foot of the hillsides and distant from the river about 1,500 feet. Here is a level plateau of sedimentary formation, elevated fifteen feet above the highest freshet recorded, on which along the river bank are located the industrial plants which support the community and where the stores and offices are located and the older portion of the town. East of the railroad the hill slopes are not so steep as to preclude occupation by dwellings. And here in New Kensington and Arnold the newer residences have been erected and future developments will mostly occur. In Parnassus there is no hillside, it being located on a level peninsula formed at the confluence of the river and the Pucketa Creek. Quite a wide flat valley extends back from the river up this creek course, where in the future it is probable, as the district grows, that a large town may be located.

"Parnassus is the older settlement, dating back to the provincial times. It is largely residential and many of its citizens are employed at Pittsburgh. The streets are permanently paved with brick, there is a public water supply and combined sewer system and the town is in a flourishing financial condition. Its borrowing capacity is reported to be approximately \$60,000.

"New Kensington and Arnold boroughs are distinctively industrial communities supported by the plants in operation within their limits. Arnold was set off from New Kensington borough about ten years ago and it is reported to be almost a certainty that the district will again be incorporated within New Kensington boundaries. The latter place has a combined sewer system, well paved streets on the flats, and a liberal borrowing capacity, its constitutional debt limit not having been approached. The assessed valuation, from figures now at hand, is \$3,350,000 and the bonded indebtedness \$118,000. The above statement being true, the municipal credit should be good for \$116,000. The borough of Arnold also appears to be well off financially if the reports be true, which show an assessed valuation of \$810,000, and a bonded indebtedness of \$8,000, equivalent to a borrowing capacity of \$48,000 or thereabouts. However, streets are unpaved, there are no public sewers and many nuisances exist in this town. The inhabitants are of the less resourceful class, largely foreigners and non-taxpayers and continually on the move.

"The water supply to all three boroughs is obtained from the Allegheny River and is furnished by the Kensington Water Company. The source is known to be polluted by sewage and the presence of turbid water in the pipes of the water dis-

trict is ample evidence that sewage organisms may pass the cribs and also be present in the water. Records of typhoid fever cases in the three boroughs are not reliable; but the data herein given are substantial enough to indicate the necessity in the interests of public health in the district, of measures being taken to keep sewage infection out of the supply. An officer of the Department made a house to house canvass and found that in the water district for the years 1905, 1906 and 1907, the cases totalled twenty-one, fifty and fifty-six, respectively. It should be borne in mind that a house to house canvass, particularly in Arnold where the foreigners are a roving class, frequently changing residence, would fail to show all of the cases. Undoubtedly typhoid fever has been much more widespread in the water district than would appear from the above figures. The local physicians fail to report the cases.

"On the hillsides in Arnold and New Kensington boroughs there are a few out-cropping springs, walled up but not enclosed, possibly liable to surface pollution, which are in use by the citizens of the neighborhood. And there are some dug wells on the hillsides. All told, there may be thirty such individual sources of drinking water. Six are reported to be in Arnold. On the flats of this place public water is said to be exclusively used except at the industries. On the flats at New Kensington there are perhaps fifteen dug wells in use, besides wells at some of the mills. Parnassus borough seems to be entirely supplied with public water, except at the works on the river bank.

"There seems to be no reason why, provided the New Kensington authorities are willing to permit the connection, the proposed sewer should not be approved, provided still further, that the extension be made under the auspices of the municipality. Whatever negotiation the borough council may make with a contractor or abutting land owner about the payment for a sewer is not a question within the jurisdiction of the State Department of Health; neither is it within the jurisdiction of the State to consider the application of an individual for the extension of a public sewer system. It is to be presumed that the municipalities do not want the proposed sewer extension else they would apply for it.

"But State sanction to the indefinite discharge of sewage from the New Kensington sewers or from private sources into the Allegheny River, or any tributary thereof, could not be consistently given. It is the policy of the Commonwealth to preserve the purity of the waters of the State for the protection of the public health. The very best apparatus which man can devise for the purification of sewage polluted waters is not absolutely germ proof and in case of accident or breakdown, human life is in jeopardy and usually sacrificed following the introduction of polluted water into the water pipes of the town. It is the bounden duty of the State Department of Health to stop the discharge of sewage into the Allegheny River above the intake of the Kensington Water Company. This cannot be brought about immediately. The municipalities on the banks of the river below New Kensington now take their drinking waters from the river and must continue to do so and hence the borough of New Kensington must in turn cease to discharge sewage into the stream. While this cannot be done immediately, steps can be taken without delay in the preparation of plans for the treatment of the borough sewage.

"The intercepting sewer to be provided for the collection of the flow from all of the public sewers should also be planned to take the flow from private sewers. While the State Department of Health must order the owners of all private sewers in the borough to discontinue the discharge of sewage into the river, the most efficient and desirable plan would be for the municipality to lay a trunk sewer to serve all sewers. This is the common policy. It seems probable that the site best adapted for the erection of a sewage disposal plant will be found outside of the limits of New Kensington borough and that in reaching this site the territory of an adjoining municipality must be traversed. In fact the cheapest and best solution of the improved sewerage and sewage disposal problem for the boroughs of Arnold, New Kensington and Parnassus will be a joint project of interception and purification rather than an independent one for each borough. Parnassus now has a system of sanitary sewers emptying into the river whose discharge must cease within a reasonable time. Arnold borough does not have a system of sewers, but is in need of such a system. The study of the treatment of New Kensington sewage involves the study of a modification to some extent of the existing sewers, because it would not be practicable to intercept the storm water discharge of the existing sewers and convey it to a treatment plant.

"Since New Kensington and Parnassus are in a financial position to make a beginning towards the ultimate treatment of their sewages, there appears to be no good reason why this should not be ordered and more especially since neither borough availed itself of the exemption clause of the law of nineteen hundred and five, and the emptying of sewage into the Allegheny River at these places jeopardizes public health at Oakmont and Verona in the Greater Pittsburgh district and other places lower down the valley.

"In view of the foregoing considerations, it has been unanimously agreed by the Governor, Attorney General and Commissioner of Health that the petitioner be notified, and I have so notified him, that the interests of the public health demand that crude sewage cease to be discharged into the waters of the State in New Kensington borough or vicinity, and that as soon as the borough of New Kensington

will in good faith notify the State Department of Health of its intention to prepare plans for the treatment of the municipal sewage and make an application for the sewer which the petitioner wishes to build, a conditional permit may be issued for this particular sewer.

"The Commissioner of Health will notify the owners of the industrial plants above mentioned that they must stop putting sewage into the waters of the State; but that the most economical and efficient way of doing this should be for them to connect with the sewer to be provided by the borough for the conveyance of all sewage in the town to a common purification plant. The State Department of Health will defer action with respect to private sewer outlets into the river for the present pending the determination by the borough of New Kensington of the details of such improved sewerage and sewage disposal problem.

"It has also been unanimously agreed that the Commissioner of Health notify, and I do hereby and herein notify the borough council of the borough of New Kensington that public health is being jeopardized by the discharge of its sewage into the Allegheny River and by the discharge of sewage from the sewers in the borough of Parnassus and that, therefore, New Kensington borough shall, either alone or jointly with Parnassus, prepare plans for the interception of all of the sewage in the municipal territory and for its conveyance to and treatment in a purification plant, and that said plans shall be submitted to the Commissioner of Health for approval on or before the first day of January, 1909.

"The local authorities are hereby requested to make an examination and test of all private wells and spring water used for drinking purposes and if such water be found contaminated, then the local authorities should and they are hereby requested to bring about the abandonment of such polluted well or spring. The local board of health is requested to warn the public that absolute safety requires that the public drinking water shall be boiled."

On October 31st, 1908, the borough of New Kensington asked permission to lay a sewer in Victoria Avenue. At that time nothing had been done towards preparing comprehensive sewerage plans in conformity with the decree of June 1908. Therefore, no action was taken on this application but on September 27th, 1909, the authorities of New Kensington were notified that the Commissioner of Health had placed in the hands of the Attorney General the matter of the enforcement of Act 182 of 1905, with respect to the discharge of municipal sewage from New Kensington sewers into the waters of the State. After several conferences the borough employed a consulting engineer and in December 1911, comprehensive plans for a sewerage system and sewage disposal works were submitted. In the decree issued by the Commissioner of Health on January 15th, 1912, the situation was discussed as follows:

"These plans were submitted pursuant to the approval of the sewerage committee of the council of New Kensington, on December 5th, 1911. The site selected for the sewage works is in Westmoreland County, near the public highway which extends up the valley of Pucketa Creek. Opposite this site in Allegheny County, there is a tract of land more secluded upon which it is feasible to locate a plant.

"The borough of New Kensington is amply able financially to assume the expense of a purification plant for its sewage and it is understood that the local authorities are not averse to undertaking the project providing the adjacent boroughs are compelled to do the same. The State having failed to bring about a co-operation between the three municipalities hereinbefore mentioned, cannot delay taking up with each municipality separately the matter of compelling some other disposal of the sewage than into the Allegheny River. There appearing to be no reason why New Kensington should longer postpone the time for treatment of its sewage and there also appearing to be many reasons why the public health demand this improvement, the State must proceed to order and decree that sewage works be erected immediately. It appears that plans submitted are worked out sufficiently in detail to show the feasibility of the project offered for approval. It will be a matter of a few weeks at the most before detail plans for construction can be prepared, a site definitely selected and the plans therefor submitted to the Commissioner of Health for approval. Meantime, certain sections of New Kensington are suffering, it appears, for sewerage facilities and the ends of justice and the

interests of public health will be subserved by granting to the borough the right to extend its sewer system in conformity with the plans now before the Department for approval, provided the borough will pledge itself to submit said detail plans for the sewage disposal works to the Commissioner of Health within a few weeks and after the same have been approved or amended to begin the construction of the works."

Parnassus, Westmoreland County, with a population of 2,200, has been fully described under New Kensington. Its industries comprise the Sterling Works of the National Lead and Oil Company, employing about sixty persons in the manufacture of white lead, the Phoenix Clay Company with fifty employees, the Globe Wire Company with twenty-five employees, the Standard Railway Equipment Company with twenty employees, J. W. Logan and Sons Lumber Company and the Electric Renovator Manufacturing Company. As already stated, the public supply for Parnassus is the same as for New Kensington and Arnold. The National Lead and Oil Company take water from the river for industrial purposes. The other plants use the public supply for manufacturing and several of them have private wells for drinking water. Parnassus has a combined sewer system with pipe ranging in size from eight to twenty-four inches in diameter, aggregating in length about five miles and discharging into the river by way of four outlets each twenty-four inches in diameter. About 150 privies are in use. The manufactural wastes contributed by the National Lead and Oil Company, amounting to about 5,000 gallons a day, contain a trace of lead and some acetic acid.

Up to the close of the year 1912, the borough of Parnassus had done nothing more than attend conferences in Harrisburg between the Commissioner of Health and representatives of the adjoining boroughs of New Kensington and Arnold and to promise to join in a common sewer system and disposal works when the other places were ready to combine. If the State is successful in its suit with Tarentum borough the situation will be materially cleared up at New Kensington and the other places.

Springdale, Allegheny County, with a population of 2,500 was incorporated as a borough in 1906. It is a manufacturing community and residential town on the west bank of the Allegheny River about sixteen miles from the river's mouth. The industries consist of the Heidenkamp Plate Glass and Mirror Company, and the Pennsylvania Glue Company, the former employing about 300 hands and the latter employing about 170 hands. People quite generally obtain their drinking water from private drilled wells, a few dug wells and a number of springs. One of the springs is owned by B. L. Elliott. It was the source of supply of the Elliott Nursery Company, the Neff Greenhouses and forty-seven families. The Springdale Water Company has a drilled well and pumping plant. The water is

raised from the well into wooden tanks. The distributing system consists of about 6,000 feet of pipe four inches in diameter and 3,800 feet of two inch pipe. In October 1908, the Commissioner of Health permitted this company to extend its distributing pipe system. In that permit was the following statement:

"While it is at once evident that the water works system is limited and not adapted to supply the entire borough with any considerable amount of water, and while it is also apparent that if the water company should purpose at any time to supply the industrial plants or to afford fire protection, it would be necessary to lay entirely new lines of pipe of larger diameters in the streets, nevertheless, it cannot be determined from the evidence now before the Department that the existing supply for drinking purposes is prejudicial to public health. Undoubtedly the company will, in proper time, and when there is a prospect of adequate revenue, introduce material changes in the water works system."

No improvements of any moment were made. It being the desire of the citizens to have a water works system extensive and ample to afford fire protection as well as a supply of water for domestic purposes, the proposition of authorizing bonds to be issued in the sum of \$72,000 for water works, sewerage and street improvements was submitted to the voters in March 1911. The local authorities requested approval of the proposed municipal water works system before the question of a bond issue was put to the people. The plans were approved by the Commissioner of Health on March 21st, 1911, it being understood that favorable action would be taken. The system proposed was to consist of drilled wells, a pumping station, a storage reservoir, and the pipes in the streets. At the end of the year 1912, the borough had purchased a tract of land on a hill elevated 350 feet higher than town and back about a mile therefrom. On this land a number of wells had been drilled and a storage reservoir constructed. The pumping station was located at the wells and the pipe lines have been laid in the streets.

In the said permit of the Commissioner of Health, the following statements were made by the Commissioner of Health:

"In case it is not practicable to obtain an abundance of pure water from the drilled well system, it is the intention of the town to filter Allegheny River water and to supply this to the system. With this contingency in view, the distributing pipe has been designed. A ten inch main has been laid out for the entire length of Colfax Road. The pumping station and filter plant will be located near the foot of this road, the filtered water will be pumped into this main and into the distributing pipe system of the town and the surplus water will overflow to the storage reservoir. It would be better for the local authorities to plan to locate the river intake and filter plant at a point up stream above the glue works where a more desirable raw water may be had. It does not follow because a filter plant can be designed and operated to render an objectionable water fairly safe that the source of supply can be selected regardless of the quality of the raw water, since filter plants do not take out all of the matter and in event of their breaking down or becoming particularly inefficient, an infection may pass through the filter into the water pipe system and cause a widespread epidemic. It is quite essential that as good raw water as practicable be obtained in the first place.

"The town is wide-awake relative to the importance of providing facilities to get rid of the water after it becomes soiled in the household. The proposed sewer system will cost \$35,000. The proposed water works system will require an expenditure of about \$60,000, the outfall sewer and sewage disposal works will cost, with the land, more than \$35,000. The assessed valuation of property in

Springdale is \$1,800,000. There is no bonded indebtedness. The borough can, therefore, borrow \$126,000; but this is not enough to pay for the building of the water works system and the sewerage and sewage disposal system. If the borough accepts the sewerage permit of the Commissioner of Health, there will be a contingent obligation on the part of the local authorities to save a sufficient portion of its moneys to cancel its obligation to build outfall sewers and sewage disposal works at the time required. By joining with Cheswick borough and by building the sewers on the assessment plan, it is possible perhaps to finance both the water works and sewerage projects. Certainly the increased sewage resulting from a more liberal use of water ought not to be emptied into the ground near the wells or springs, and certain it is, the abandonment of these wells and springs will be hastened by an adequate public water supply. So far as the pollution of the river is concerned, the situation to-day is to be preferred over that after sewers will have been built in Springdale and the sewage is discharged into the river. The taxpayers and citizens of Springdale must understand that the temporary right granted to the town to empty its sewage into the river is given for the express purpose of aiding in the sanitary improvement of conditions on each premise in the borough; but that it is given under the express stipulation that the community will at the earliest practical moment erect sewage disposal works and treat the sewage. It will not do for the local authorities or the citizens to lightly treat this decree or to proceed in a careless way to expend all money available regardless of the obligation of the borough to treat its sewage in the near future."

The borough of Springdale in January 1911, asked permission to install a comprehensive system of sanitary sewers and for the discharge of sewage temporarily into the Allegheny River. The municipal territory has a river frontage of about two miles and extends back from the river about a mile to the summits of the hillside. The village lies on the flats along the river front and back to the Pittsburgh and Freeport Road about a quarter of a mile. This section has a gentle slope to the Allegheny and is elevated above freshets. Beyond the flats the land rises on gradual grades to an elevation of about 300 feet. Thus excellent natural drainage facilities are afforded. The Pennsylvania Railroad tracks parallel the river and are distant therefrom about 400 feet. Most of the buildings are located between the Railroad and Freeport Road. Colfax Road is the main thoroughfare extending northerly from the river out into the township. The drainage of the borough is either directly into the river or into two small tributaries, Tweneys Run (or Shoups Run) and an unnamed water course. Tweneys Run rises out in the township 3.5 miles distant, drains a hilly country, sparsely populated and empties into the Allegheny River within the borough limits near the down stream boundary of Springdale. There is a switch from the Pennsylvania Railroad which extends up the valley of this run to the Harwood Coal Mines. It is in this valley near the Freeport Road that sites have been selected upon which to erect sewage disposal works. The Heidenkamp works are along the bank of the river immediately below the Federal Lock Dam. A twenty-four inch sewer which also receives the waste from the grinders discharges into the river at the lower end of the plant.

The Glue Works are situated along the river bank just above the Government Dam. Drinking water is obtained from drilled wells located on the premises and water for industrial purposes is obtained

from the river. The industrial wastes and sewage are discharged into a cement sedimentation tank. The fats are removed from the surface of small tanks and are sold at a profit, the liquid effluent reaching the river. This plant was installed by order of the Commissioner of Health. It was the intention of the Department that the effluent from the sedimentation plant which is merely sewage from which the heavier suspended matters have been removed should be subjected to treatment at the time the sewage of Springdale borough was subjected to treatment and preferably at the same point. Therefore, the sewage from the Glue Works bears an important relationship to the problem of sewage collection and disposal for the borough. It is estimated that 2,500,000 gallons of water are used industrially at the Glue Works each twenty-four hours.

In the proposed system, sanitary sewers are to be built and connected to all houses. The existing drains will be used for storm water only.

In the permit approving the Springdale sewerage system issued March 16th, 1911, the Commissioner of Health had the following statements to make:

"The majority of the members of the borough councils of both Cheswick and Springdale have declared informally to representatives of the State Department of Health that they were prepared, if so required, to jointly consider and make plans for sewage disposal works where the sewage of both municipalities could be treated. In fact, the permit of 1910 to Cheswick borough was issued with the general understanding that Cheswick would co-operate with Springdale in the selection and purchase of a site in or along the valley of Shoups Run for the erection jointly by the two municipalities of a sewage disposal plant and that these two places would jointly prepare plans and estimates of cost for sewage works and submit them to the Commissioner of Health for approval.

"Springdale borough has an assessed valuation in round numbers of \$1,800,000, and there is at present no bonded indebtedness. If the proposed bond issue of \$72,000 carries, then the municipal borrowing capacity will be \$54,000. Still further, if the cost of the sewers be assessed, two-thirds on the abutting properties and one-third on the municipality, the borough will be in a financial condition permitting it to make some material progress towards the purification of the town's sewage in the near future. Cheswick borough is not so well situated financially; but it is in a position to assume its share of the cost of preparing plans and of purchasing the site for the disposal works. These plans should be prepared without delay and the boundaries of the land necessary for the works should be defined and the land should be acquired jointly by the boroughs if possible. The Glue Company might prefer to enter into a contract with the municipality to pay an annual rental for the use of the public sewer system and sewage disposal works rather than pay a proportionate share of the cost of the erection of the plant. All of the liquid wastes of the glue works that is sewage must, at the time the borough treats its sewage, be also treated, and it should be more economical for the company and for the municipality to have one plant in which this treatment would be effected rather than to have independent plants."

The borough was required to prepare plans either alone or with the borough of Cheswick for sewage disposal works upon a site to be designated and submit them for approval before July 1st, 1912.

On July 11th, 1912, the Commissioner of Health extended the time for the preparation of plans. In this decree the following statements were made:

"The policy of the State Department of Health is to bring about the treatment of the sewage of Springdale at the earliest practicable moment, because the waters are used as a source of water supply by the public at several points along

the river below Springdale. This does not necessarily mean that a complete sewage disposal plant by means of which organic matter may be reduced to inorganic form shall be built and operated by the borough of Springdale in the immediate future; but it is the intention of the State that some modification of the sewage of Springdale shall be brought about without delay and having this in mind, the borough of Springdale was permitted to install its sewers and to discharge its sewage temporarily into the river. There is no sufficient reason known to the Department why Springdale borough should not proceed forthwith to prepare plans called for in the decree of March 16, 1911, and when these plans shall have been submitted to the State Department of Health it will be time enough to consider to what degree the sewage of Springdale shall be modified, taking into account the financial condition of Springdale and other pertinent matters."

The borough of Cheswick, Allegheny County, population about 300, is a residential community located about fifteen miles above of Pittsburgh on the west bank of the river. The industries comprise the Pittsburgh Tool and Drop Forge Company, employing fifty hands and the Elias Block Distillery. Truck gardening is carried on to quite an extent. The eastern or up stream half of the borough is supplied with water by a private company known as the Cheswick Water Company. The source is a drilled well. Copious springs furnish drinking water to the greater part of the population. Sewage is generally disposed of into cesspools or privy vaults, a practice that has resulted in the pollution and abandonment of many of these springs. Trouble caused by overflowing cesspools finally resulted in the designing of a sewerage system which has been the subject of several decrees.

The first decree was issued in June 1908. In this decree the following statements were made by the Commissioner of Health:

"Nearly all the houses in this district (Eastern half), probably thirty-two, are fitted with bath rooms and inside water closets. These dwellings and other contemplated for the neighborhood are of modern type and require the latest sanitary facilities for the comfort of the owners. The character of the ground is such that except in a few locations on the flats underlaid by beds of alluvial gravel, successful house drainage by means of cesspools is practically impossible. Most of the hilltops and slope property is underlaid by several veins of clay practically impervious to water, from which flow numerous springs. The present method of sewage disposal of most of the houses is into cesspools or privy vaults. Those located on the flats are purposely made of the percolating type and have given reasonable satisfaction for a short period—from two to seven years—when they become clogged up. There are no springs on the flats. There is at least one well in this district and the slopes in the eastern district where are the water pipes there remains one spring in use. The reason for abandonment of the numerous springs formerly used for drinking water was the overflowing of the cesspools on the hillside and the danger of underground contamination of the sources of water supply.

"The local authorities purpose to take up the present fifteen inch private sewer in Allegheny Avenue from the railroad northerly and relay it at a lower elevation and make it the trunk sewer of the sewer system for the eastern district. A lateral is provided in every street now laid out, with facilities for extensions. If negotiations cannot be closed with Caroline Jacoby and others for the taking over by the borough of the private sewer, then the petitioners purpose to lay an independent main in Allegheny Avenue.

"Two miles below Cheswick on the opposite side of the Allegheny River is the borough of Oakmont and adjacent thereto is Verona borough, both of which are supplied with water by the Suburban Water Supply Company. This company's water works intake is at a point in the river near the easterly borough line of Oakmont. Some complaint has been made by the citizens of the district of the quality of the water and the Suburban Water Company has been requested by the Commissioner of Health to prepare plans for a more efficient purification of the river water than that accomplished by the present intake cribs located in the bed of the stream. The two boroughs of the district have also been required to

prepare plans for some method of sewage disposal than into the Allegheny River, because of the proximity of their present sewer outlets to the water supply intakes of the city of Pittsburgh and district.

"Below Cheswick, on the north bank of the river, at the hamlet of Montrose, in O'Hara Township, is the pumping station and intake of the Allegheny City water works system. Seven miles above Cheswick on the same side of the river is the borough of Tarentum. The Commissioner of Health has issued a decree to the authorities of Tarentum and also to the borough of Brackenridge immediately above, and to the village of Natrona in Harrison Township, to prepare plans for some other method of disposal of sewage than into the river. In all of these places the problem is rendered quite difficult because of the topography and the fact that many of the sewers receive storm water whose elimination must be effected before the erection and operation of purification works can be conducted on any other than a prohibitive basis from the standpoint of cost. Nevertheless, it is the purpose of the State to bring about at as early a date as practicable the discontinuance of all sewage disposal into the Allegheny River or its tributaries, and consistent with this policy, all municipal authorities should conform their sewer plans.

"The petitioners for Cheswick borough contemplate using the proposed sewer for house sewage only. The assessed valuation of the borough is reported to be \$520,000, which gives a borrowing capacity of about \$36,000. The present bonded indebtedness is \$500,000. The cost of the proposed sewers is estimated at \$5,000, so it is seen that the borough will have on this basis the ability to borrow \$25,000, after the proposed sewers shall have been built. Undoubtedly when the times demand sewerage for all of the municipal territory, some other point for a sewage disposal plant will be secured than at the outlet of the Allegheny Avenue sewer proposed. The natural slope of the ground is more towards the mouth of Pillow Run for the western district and towards the mouth of Tawney Hill Run, or Shoop Run, which is to the east in Springdale borough.

"If the borough should make a comprehensive study of this subject and be able to select a definite site for the ultimate disposal works where all of the sewage of the borough should be delivered and treated, and find that the cost of conducting the sewage to this point at this time would be prohibitive, then the erection of a temporary sewage purification plant at the foot of Allegheny Avenue would appeal more strongly to the citizens and taxpayers of the borough as a practical expedient and the economies of the temporary plant would be thus proven.

"In any event, because of the close proximity of Cheswick to the intake of the Allegheny City Water Works, and the great menace to public health which would be constituted by the discharge of the public sewer into the Allegheny River in Cheswick it does not follow that local conditions prescribe,—or admitting that the present method of sewage disposal by cesspool and privy is a menace and a nuisance of a local character—that there is not some other remedy than the proposed sewer for this condition and so it would appear that the interests of the public health would demand that the borough of Cheswick should prepare plans for the treatment of the sewage from the proposed sewer outlet, (if it persists in building the sewer) and submit the same to the Commissioner of Health for approval.

The borough did not build under the foregoing permit. The borough, however, selected a site for a sewerage purification plant on the river at the mouth of Pillow's Run in the extreme down stream end of Cheswick and submitted plans for the purification of the borough sewage here. Pillow Run drains two thirds of the area of Cheswick. However, the local authorities did not wish to build this plant at once but asked permission to discharge sewage temporarily into the Allegheny River at the foot of Allegheny Avenue through the existing fifteen inch sewer owned by Caroline Jacoby and others. In a decree issued August 25, 1908, withholding approval the Commissioner of Health made the following statements:

"The site selected for the disposal works is about the lowest point in the borough. There are a few houses in the neighborhood, one within about 200 feet of the site. It should be borne in mind that there is more or less odor in connection with any sewage disposal works, and that it is desirable to locate the plant as far away from the dwellings as possible and feasible. Where the plant is located near buildings, greater care and high class maintenance is necessary to obviate a nuisance. It would be better to establish a pumping station at this point and to raise the sewage to some remote point.

"It is evident that the borough has means at its disposal to defray the cost of the preparation of complete detail plans of a comprehensive sewerage system and a permanent sewage disposal works. Such plans have not been submitted. The plan now before the Department, if modified as herein proposed, might answer for temporary works, and possibly a permanent plant, if proximity to dwellings be eliminated from consideration.

"The effort in the design has been to secure sewerage facilities at the minimum cost. While the site for treatment works may be ultimately used, yet the borough purposes to temporarily utilize an existing sewer. There is no knowing how much sewage may be added to that now being emptied through the existing pipe into the Allegheny River, and it is clearly in the interests of public health that all of the sewage should be treated. Either an adequate plant must be installed or each individual estate must care for its own sewage independently of others. The drinking water of municipalities below must not be contaminated.

"It is possible for the borough during the early years of the existence of the sewer system and disposal works, to dispose of all of the sewage at the plant without creating a nuisance but it is good judgment to forecast the time when the site for the plant will have been outgrown and some other permanent location for treatment works, remote from habitation, must be adopted. It would be better were the borough to thoroughly consider this subject at the outset and erect works at the permanent locality. The municipality has a borrowing capacity sufficient to defray this expense, provided a majority of the citizens want a system of sewerage and sewage disposal works."

The borough modified the sewage disposal plans in conformity with the decree and on October 20, 1908, the Commissioner of Health approved the same.

The borough held an election and defeated the proposition to increase the indebtedness for the construction of the sewer system and disposal works. The people in the westerly part of Cheswick had little need for a sewerage system but the people in the eastern part of the borough could not well get along without sewers. However, the borough council went on and built the sewers in the eastern part of the borough and the trunk sewer to the site of the sewage disposal plant in the lower end of the town. The people living in this vicinity objected vigorously to the temporary location of disposal works here which resulted in the adverse vote given in June 1909. Therefore, the borough asked permission to use the storm sewer down Allegheny Avenue to the river as an outlet into which to empty the sewage from the new sewers built in the eastern section of Cheswick. The building of the new sewers has exhausted all available funds. If a permit is granted it will enable the borough to collect half the cost of the sewer system from the property owners, so on April 1st, 1910, the Commissioner of Health issued a permit to the borough to temporarily discharge the sewage into the Allegheny River near the mouth of Pillow Run. This was not satisfactory. It required the changing over of the grades of some of the new sewers which grades were established directly contrary to the plan approved by the Commissioner of Health and on July 14, 1910, after sending a representative to interview the borough authorities and representative taxpayers, the Commissioner of Health issued a permit to use the Allegheny Avenue sewer this being considered the most practicable way in view of the compact situation to temporarily solve the sewerage problem, but it was stipulated that on or

before July 1st, 1912, Cheswick should either alone or in conjunction with Springdale, submit to the Commissioner of Health for approval plans for permanent sewage disposal works. On July 31st, 1912, the Commissioner of Health extended the time in which Cheswick and Springdale boroughs are to consider and prepare plans for joint sewage disposal works.

Oakmont borough, Allegheny County, population 3,400, lies on the east bank of the Allegheny River about twelve miles above the confluence of this stream with the Monongahela River. It is largely a residential town and the home of many persons doing business in Pittsburgh. Its industries comprise the Verona Tool Works employing about 150 men, located on Plum Creek, the plant of the William B. Scaife & Sons Company, structural iron manufacturers, with upwards of 350 employees, and the works of the Crescent Forging Company which employs about 60 hands. The two last named plants are located on the banks of the river. The Suburban Water Company of Allegheny County, supplies the town. The water is derived from filter cribs buried in the Allegheny River just above the borough, whence it is pumped direct to consumers in Oakmont and Verona, the adjoining borough to the south. The surplus water goes to an equalizing and storage reservoir on the hill back of Verona in Unity Township. From this reservoir the water is supplied to consumers along Plum Creek in Unity Township.

This water company desiring to extend its water works system, requested approval of the existing system and a permit to make extensions. On February 8th, 1910, the Commissioner of Health issued a decree and in it the following statements were made:

"During the fall of 1905, the water company was compelled to enlarge its plant to meet the rapid growth in population in the two boroughs and the two townships, which it did by laying a new crib in the river and installing a new pumping engine. It also extended water mains through out the streets. In the district supplied by this company there has been a large amount of typhoid fever. For the first six months of 1907, the typhoid cases in Verona were reported to number twenty and in Oakmont twenty-nine. For 1906, there were reported eighty-eight cases in Oakmont and eight cases in Verona. It is known that physicians neglected to render morbidity reports to the local health authorities. Analyses of samples of water collected from the piping system at various times have shown the presence of intestinal organisms and, therefore, the public has been warned by the borough officials of Oakmont to boil the water. While the public water supply was availed of quite generally, some drinking water is obtained from private sources in the borough. Along the road in Wildwood Creek ravine there are a number of houses using wells. These wells are near the road and the foot of the slope, on which slope are numerous privy vaults sunk in gravelly soil and in close proximity to the wells. In the central part of the borough, between First and Second Avenue, there are several houses not yet connected with the sewer system, privies and wells being located near each other on these properties.

"At the Bollinger Andrews Company plant (Verona), there is a large spring on the hillside which is its source of supply. The spring itself is walled up and closed over, a pipe leading from it to a half barrel nearby where residents in the vicinity on the highland above are said to come and fill water pitchers. From this barrel the water is piped to a tank and thence to the works. Unless sewage is properly disposed of at the properties on the hill above the spring, there is a possibility of surface contamination and sub-surface pollution. The General Steel Castings Company obtains water from a small run fed from springs in the hillside just back from the plant. This water is used in the boilers in preference to the cor-

rosive waters of the borough's supply. The employees drink the spring water and it is also furnished to their tenant houses, accommodating twelve families. The watershed is unpopulated, excepting one farm house and it should be an easy matter to protect this supply.

"Owing to the source of the public water supply of Oakmont and Verona, it may be expected that typhoid fever will continue to prevail, at least until two things shall have been accomplished, namely, the filtration of the said supply and second, the diminution of the pollution of the Allegheny River by sewage above the Suburban Water Company's intake. The latter work is being gradually accomplished by the State Department of Health and is essential because the most advanced processes of water purification do not afford absolute insurance against infection of the drinking water in case of accident or careless operation of the filter when the source from which the raw water is obtained contains pathogenic poison.

"Reliance upon a filter crib sunk in the bed of the river is likely to prove disastrous to those drinking the water drawn from such a crib if the practice be continued throughout a long period of time. Even where apparatus for water purification is built to admit of all possible regulation and manipulation constant care must be exercised to secure a high and safe degree of efficiency. Therefore, it should be readily apparent that an apparatus like a filter crib which is not subject to control is totally unsuited to afford assurance to the public health to the extent that water consumers may drink this water without risk of contracting disease at any time. In the case of Wilkinsburg vs. the Pennsylvania Water Company, it was proven to the satisfaction of the court that the filter crib of said company was not a sufficient safeguard to public health, although the filter crib was constructed according to the best plan and kept in repair as much as possible, and although much of the time the water drawn from this filter crib and supplied to the public was pure water.

"The Suburban Water Company might not be able to repair a break or leak in its filter cribs for several months, owing to the high stage of the river, and meantime the public might be supplied with impure water. The Suburban Water Company, under its charter, is required to furnish a pure and wholesome water to the public. The company should forthwith provide apparatus for the treatment of the filter crib water with a germicide at such times as daily observations show the water to be at all turbid, or frequent bacteriological examinations may show the water to contain sewage organisms. And the company should proceed forthwith to prepare plans and estimates of cost for the installation of a modern water purification plant, and these should be submitted to the State Department of Health for approval. The Department cannot approve the filter cribs. The new one was built without approval of the Department and without application for approval. The company's explanations have been received, but they are not satisfactory. It is not good policy to wait until an epidemic prevails in a district by reason of distribution of impure water therein, in order to establish the necessity for the building of a modern filter plant and the mere fact that analyses of the water now produced by the filter cribs show it to be free from sewage pollution does not remove the prejudice to public health which is ever imminent so long as the filter cribs are the only means of purifying the river water. By careful daily observations of the water drawn from the cribs and the use of chemicals to disinfect the water whenever it is turbid, even to the slightest degree, the water may be rendered safe for public use at all times. But the intent of the State in creating the Suburban Water Company was that this private corporation should have before it first and foremost the obligation to furnish a pure and wholesome water and the company cannot fulfill this obligation under the circumstances, until it has installed and put in use an apparatus of the most approved type for the purification of water."

On July 15, 1910, the Commissioner of Health approved plans for an emergency hypochlorite treatment of the water supplied by the Suburban Water Company to the public within its charter territory. On April 1st, 1911, the Commissioner of Health approved plans for a proposed water filtration plant. In this permit the Commissioner made the following statements:

"According to the 1910 census the population of Verona is 2,849, and that of Oakmont 3,436, a total in the two boroughs of 6,285; the majority of whom are patrons of the Suburban Water Company. The average daily consumption of water in the district supplied by said company is 1,250,000 gallons. The filter plant as proposed will accordingly be ample in size to take care of this consumption, as three of the filters at their rated capacity will produce 1,500,000 gallons of water per 24 hours, thus leaving at all times one filter unit in reserve. Furthermore, the proposed rate of filtration does not exceed that found practicable in plants of similar nature. No provision has been made for by-passing the reservoir. All of the filtered water will pass into this basin, which has a capacity of 1,600,000

gallons, and thence to the distributing system. It is presumed by the Department of Health that this is the method that will be followed at all times, except in case of a breakdown at the filter plant which might have the effect of completely putting this plant out of service. In such a contingency, it would no doubt, be necessary to resort to the present method of water supply, namely, dosing the water pumped through the cribs with a suitable germicide, as is now customary, before furnishing it to the public. This practice should be resorted to only as a final expedient and if at any time it becomes necessary, the Commissioner of Health should be notified and the public should be warned to thoroughly boil all water before drinking it."

Oakmont has extensive sewerage with four outlets, one into Plum Creek and three into the river. They serve ten miles of sanitary sewers and over one mile of combined sewers. About 3,000 persons reside in the dwellings connected to the public sewer system. There are few cesspools or privies in use and none where sewers exist. On August 14, 1907, the Commissioner of Health issued a permit to Oakmont for the construction of certain sewer extensions and requiring the preparation of plans for the collection and purification of the sewage. In this decree certain statements were made as follows:

"The incorporated territory is very favorably located on a long incline sloping westward to the river and southerly to Plum Creek, which creek forms the southern boundary of the borough separating it from Verona. The town stretches along the river for one and three-quarters miles. The shores bowing outward form a crescent, so that the currents are reported to be greater along the opposite or west bank of the river passing by Oakmont. The northern boundary is a small stream known as Falling Springs Run, this part of the borough back from the river being well wooded and unoccupied. The easterly boundary is Plum Township and the land in the township contiguous to the borough continues to ascend gradually to the table lands above. The natural drainage facilities in proximity to Pittsburgh have attracted many well-to-do men whose avocations call them to Pittsburgh during business hours, but whose means enable them to command first class suburban residences and a majority of the dwellings in Oakmont have been built and are occupied by this class of citizens. On the medium sized lots in the town houses of a moderate cost have been erected. Even the homes of the less resourceful employed in the manufactories present a neat appearance, with few exceptions. The streets are generally well paved, and broad side-walks have been permanently constructed, shade trees are numerous and all told the borough presents an attractiveness and tone which vouchsafes to it a continued growth as a residential suburb of Pittsburgh and reflects credit to those in local authority. The railroad is back from the river over one-quarter of a mile through the central part of the borough; but it approximates the river bank at the north end and above follows along said bank. The only land in the town which is ever reached by high freshets is a small tract between the railroad and the river in the southeastern part, principally in the vicinity of Plum Creek. No permanent use is made of this land.

"Surface drainage from the hills is maintained principally in the street gutters or the natural valleys of which there are several coming toward the river, but the water is conducted largely, if not wholly, underground to the river from the railroad or near it by means of sewers.

"The local Board of Health has requested the assisted of the State Department of Health in solving the vexatious problem of how to stamp out the typhoid disease from the community. The surest way would be to discontinue the use of all wells and springs in the borough and to abandon the Allegheny River as a source of supply because it contains pathogenic poison. A great deal of infection exists in the Tarentum district, where typhoid fever is practically endemic. This place is 8.5 miles above Oakmont's water works intake, so that the sewage organisms discharged into the river at Tarentum through that borough's sewers, within two or three hours may pass over and possibly through Oakmont's filter crib and be introduced into the homes of the citizens of Oakmont. There is practically no way provided to regulate the filter crib. If it gets out of order or be imperfectly purifying the river water, as is known to have been the case on various occasions, there is no way of manipulation provided to increase the efficiency. Only by the most modern and improved filtration apparatus provided with means of regulation and control, can badly sewage polluted waters, such as the Allegheny River, be rendered constantly safe and wholesome for domestic uses. And even then there is danger that in case of breakdown or accident the poisonous source may be temporarily or accidentally supplied to the people. Hence as a public precaution it is demanded that sewage should cease to be discharged into the Allegheny River above those points from which the water is drawn as a source of public supply.

"The borough asks permission to extend the sewer system according to the comprehensive plan adopted prior to the law of 1903, under which the existing sewers have been built.

"The case of the petitioners is one in which the point to be decided relates not so much to the necessity of the discontinuance of the discharge of the borough's sewage into the river, which necessity is paramount and must be brought about at the earliest practicable moment, as to whether the interests of the public health will be subserved by permitting the petty lateral extensions immediately contemplated. The few houses to be connected with the extension will not contribute a measurable increase to the menace of the downstream water supplies. The borough's sewers are now about one mile and a half above the Allegheny City water works intake, 3.4 miles above the pumping station of the Pennsylvania Water Company and about five miles above the city of Pittsburgh's intake. If permission be denied the borough, a material hardship will be imposed upon private individuals and upon the borough in general and this cannot aid in hastening the adoption of sewage purification works for the entire sewage of the borough. Were the State to demand the preparation of plans and the construction of a municipal sewage plant at an early date, and at the same time permit the proposed sewers to be laid, possibly the good accomplished by thus aiding the establishment of modern sanitary facilities might entirely overbalance any possible harm which the small amount of added sewage to the borough system might do. But it is not necessary that general sewerage extensions should be made in the borough and the sewage therefrom discharged into the Allegheny River.

"Since it is not economical, but it is in fact prohibitive in cost, for a town of Oakmont's size to attempt to treat mingled sewage and storm water, this fact dictates that there should be a separation of house drainage and storm water. Separate conduits should be provided. Since but a small portion of the existing sewers in the borough are combined, the expense of this separation would be moderate. It is reported that a storm drain is to be laid in Railroad Avenue. If this be so it will be prudent for the local authorities to consider the advisability of making this a part of the purely surface drainage system of the borough, and to exclude all house drainage of a sewage character from storm water structures.

"The site of the disposal works needs to be carefully considered. Preferably a secluded spot should be selected in a locality not likely to be in demand for development purposes. There is a possibility that the intercepting system and disposal problem might be considered jointly by the boroughs of Oakmont and Verona, to their mutual advantage.

"The borough authorities are informed that the Department is notifying the owners of private sewers now discharging into the river within the borough limits, and the owners of privies located on the banks of the stream, that the discharge of all sewage into the waters of the State must cease. Where possible or practicable, the sewage from every property should be contributed to the public sewer system. The local board of health should be commended for its activity and efficient work. The injunction to boil water should be reiterated from time to time. The Department of Health will co-operate with the water company in the effort to render the public supply pure and wholesome. All wells and springs in the borough should be ordered abandoned if tests to be made frequently prove the waters thereof to be polluted."

The borough of Verona, population of 2,800, is a manufacturing community adjoining the borough of Oakmont, being separated from it by Plum Creek. The industries include a plant of the General Steel Castings Company, employing about 350 hands, the works of the Pittsburgh Pole and Forge Company, the structural steel plant of the Bollinger Andrews Company, and the Anderson Planing Mill. The manufactural wastes from these industrial plants are not particularly deleterious to the potability of the river water. The water supply has been described under Oakmont and also the prevalence of typhoid fever. Verona is quite thoroughly sewered on the separate plan. The sanitary sewer system has a twenty-four inch outlet serving about six miles of sewers. There are no cesspools in use and very few privies, compulsory connection with the sewers being enforced. The storm water system has two outlets, one four feet in diameter and the other twenty inches in diameter. In addi-

tion to the public system, there are various private sewers discharging into the river and into Plum Creek. Plum Creek receives drainage from the coal mine which gives a characteristic color to the stream bed. On August 14, 1907, the Commissioner of Health issued a permit for certain public sewer extensions designed to relieve nuisances in two portions of the town. In this decree the following statements were made:

"It appears that the borough of Verona is a manufacturing community of about 2,700 people, located on the east bank of the Allegheny River nearly opposite but slightly above the Allegheny City water works intake, and 1.75 miles above the water works intake of the Pennsylvania Water Company, 3.25 miles above the city of Pittsburgh water works intake and eleven miles above the confluence of the Allegheny and Monongahela Rivers.

"While the public supply is availed of quite generally, some drinking water is obtained from private sources in the borough. Along the road in Wildwood Creek ravine there are a number of houses using wells. These wells are near the road and the foot of the slope, on which slope are numerous privy vaults sunk in gravelly soil and in close proximity to the wells. The borough purposes to extend a ten inch sewer up Wildwood Avenue in the ravine by the houses now located there, and then up Church Street and alleys, and in Third Avenue and alley in rear to South Avenue, comprising in all about 2,400 feet of eight inch sewer and 1,300 feet of ten inch sewer. Also an eight inch sewer extension in Jones Street to admit of the abatement of nuisances caused by privies in the vicinity of the Pittsburgh Pole and Forge Company works. This extension will amount to about 600 feet in length.

"The injunctions of the Oakmont Board of Health to boil the water, and it may be that the Verona Board of Health has issued similar warnings, should be heeded. The discharge into the Allegheny River of sewage, especially immediately above Oakmont, menaces the lives of the public in the Verona district and must cease. In turn those municipalities and the public relying for drinking water upon the Allegheny River and living below Verona must be protected, and in considering the question broadly the State authorities cannot consistently permit Verona or Oakmont to defile the Allegheny River while requiring up-stream municipalities to discontinue such defilement. The poison emitted from Verona sewers into the river within 3.25 miles of and above the water works systems supplying half a million people may be introduced into the pipes of any of these systems and be drunk and start upon its work of destroying human life within less than an hour from the time the poison leaves the body of the individual using the Verona sewerage system.

"The assessed valuation of Verona is reported to be \$1,783,245, which if true, leaves a borrowing capacity of about \$52,000 which is a sum amply sufficient to more than provide under all ordinary conditions for the installation of a municipal sewage plant of the size demanded in the interests of public health at Verona. While the proposed sewer extension will do away with the two worst nuisances in the borough namely, those existing along Wildwood Avenue and those in the vicinity of Jones Street, (provided the borough authorities compel the abandonment of all privies and the connection to the public sewer system in these localities) and the public health seems to demand these improvements, and the amount of sewage to be contributed by the said proposed extensions will not measurably increase the present sewage pollution of the river in Verona, because most of it goes to the river sooner or later now, yet in order to accomplish the best results, the sewer system should be extended to embrace all sewers in the borough and every property should be compelled to connect in order that all sewage, whether from dwellings or industrial plants, should be conveyed by the public sewer system eventually to the sewage purification plant. Therefore, in anticipation of the treatment of the sewage, all roof and storm water should be excluded from private connections to the public system.

"Since one of the main outlets of the Oakmont borough system discharges into Plum Creek, and in the study of the most important question of the selection of a secluded site for a sewage purification plant for the treatment of Oakmont's sewage, it might be found very desirable for Oakmont and also for Verona to unite in a combined or joint intercepting system and disposal works, the attention of the local authorities of both municipalities might well be called to the possibility."

The borough did not build the sewers and hence Verona did not prepare the comprehensive sewerage plans and submit them for approval. On July 24th, 1908, the Commissioner of Health extended the time to January 1st, 1909 and approved of the extension of cer-

tain sewers by the borough in the meantime. The borough's funds became exhausted and for various reasons no construction under the decree was accomplished until 1911 when bids were advertised and received for the completion of the building of the sewers mentioned in the last decree and for the laying of other sewers. Failure on the part of the borough to prepare plans for the treatment of its sewage and for the submission of these plans to the Commissioner of Health for approval was considered by the Department to constitute an annulment of the sewerage permits and, therefore, upon receipt of the notice that Verona borough proposed to extend its sewer system in 1911, the matter was called to the attention of the Attorney General. It was ascertained that Verona borough desired to obtain a decree similar to the original one of 1908 and on August 30, 1911, the Commissioner of Health granted a permit subject to the following conditions and stipulations:

"FIRST: That all storm water shall be excluded from the sewers herein specifically approved and that no other sewer shall be built or extension to the existing sewers be laid unless plans therefor shall have been approved by the Commissioner of Health.

"SECOND: This permit is issued under the express stipulation that on or before January 1st, 1912, the borough shall prepare a plan for the collection of all of the sewage of the borough and for its conveyance to and treatment in sewage purification works and shall prepare a plan and report on such sewage disposal works and sewerage improvement and shall submit the same to the Commissioner of Health for approval. This work would best be done in co-operation with the borough of Oakmont. When plans therefor shall have been approved, modified or amended the Commissioner of Health, the Governor and Attorney General will fix a time when such sewage disposal works shall be built and put in operation.

"THIRD: If at any time in the opinion of the Commissioner of Health the sewerage system or any part thereof has become a nuisance or prejudicial to public health, then the borough authorities shall adopt such remedial measures as the Commissioner of Health shall advise or approve.

"FOURTH: This permit to discharge sewage into the waters of the State shall cease on the first day of January, 1912, but if on such date the conditions and stipulations of this permit shall have been complied with, then the Commissioner of Health will extend the time in which the sewage of the borough may continue to be discharged into the Allegheny River, but it is expressly stipulated that the interests of the public health demand that the sewage of Oakmont and Verona shall be treated in proper works at the earliest practical date, consistent with the execution of the State policy relative to the treatment of the sewages of all the municipalities in the Allegheny Valley in proximity to Pittsburgh.

"FIFTH: No pathogenic material from any laboratory shall be permitted to discharge into the sewer system. The proper authorities shall cause these wastes to be destroyed in the premises.

"SIXTH: Detail plans and profiles of the sewers as built shall be prepared by the borough and filed in the office of the Commissioner of Health on or before the conclusion of the current season.

"The borough authorities are requested to compel the owners of all estates abutting a public sewer, whereon nuisance or menace exists, or from which a private sewer discharges into any river, creek or natural water course, to connect such properties with the sewer system and to discontinue the discharge into State waters. The local authorities shall promptly notify the State Department of Health of the names of such owners from whose properties sewage is discharged into the waters of the State. Upon failure of the local authorities to compel the discontinuance of such discharge, the State Department of Health will take the matter in charge."

During 1912, Verona borough reported progress on plans for sewage treatment works. Negotiations were being had for the acquirement of land upon which to erect a plant. Oakmont declined to join with Verona. The situation at Tarentum was being watched. If the Department is successful in the courts respecting the Tarentum sewage situation there, it is anticipated that no great difficulties will be encountered in consummating the State policies at Oakmont and Verona.

At Claremont, or Warner station, on the Pennsylvania Railroad, O'Hara Township, Allegheny County, there are two public institutions located on the west bank of the Allegheny River, namely the Allegheny City Home and the County Workhouse, representing in all a population of about 1,500 persons. The Ross pumping station at Aspinwall of the Pittsburgh water works system is a short distance only below this point and also the intake cribs of the Pennsylvania Water Company at Nadine. The prevalence of typhoid in Pittsburgh and vicinity led the Commissioner of Health to require these public institutions to purify their sewage. The Allegheny City Home, in accordance with decrees issued November 2nd, 1907, and June 25th, 1908, and the Allegheny County Workhouse in accordance with a decree issued on March 8th, 1907, have constructed independent sewage disposal works and are now treating their sewage by means of septic tanks and sprinkling filters.

At Nadine, a station on the Allegheny Valley Railroad located on the south bank of the Allegheny River, just above the city of Pittsburgh line and about a thousand feet above the intake of the city of Pittsburgh's water works system, the Pennsylvania Water Company operates a series of filter cribs in the bed of the river from which water is drawn and supplied to a population of about 88,000 persons in Pittsburgh and the adjoining boroughs in Turtle Creek valley, the average daily consumption being in the neighborhood of ten million gallons. The territory includes the boroughs of Wilkinsburg, Edgewood, Swissvale, Rankin, North Braddock, East Pittsburgh, Turtle Creek, Wilmerding, Pitcairn, Trafford City; parts of the townships of Wilkins, Braddock, North Versailles, and Patton; and the Thirteenth Ward of the city of Pittsburgh.

At the Nadine pumping station the floor of the engine house is twenty-seven feet above the level of the Aspinwall dam, two miles below Nadine. This dam forms a pool in the Allegheny River which extends several miles above the Pennsylvania Water Company's plant. This government dam was completed in the latter part of 1908, prior to which the low water in the river opposite Nadine station was about forty feet below the engine house floor and the highest flood level reached was about ten feet below this floor. There are three intake cribs located opposite and a little up-stream from

the pump house along the north shore of the river and about 300 feet distant therefrom. Crib No. 1 is a timber structure, 300 feet long by 32 feet wide and 4 feet deep. Excavation was made in the rived bed and the crib was floated into position and then sunk to its bed in the excavation. Heavy stones were put on top and around the sides and over all was deposited the sand and gravel of the original excavation, making a fill of about five feet over the top of the crib to the level of the river bed. Cribs Nos. 2 and 3 are located in line with and immediately above Crib No. 1 and are of similar construction. Pipes extend from these cribs to the pumping station. The capacity of the three cribs depends upon their condition and the stage of the river. Some of the flow of the water in the crib comes from the ground beneath. Two facts prove this. The alkalinity between the crib water and the river water is often in the ratio of four to one. When the pumps are stopped the water stands in the inlet chamber at a higher elevation than the river water, or did so prior to the creation of the river pool. Over fifty per cent. of the water formerly secured came from the ground during ordinary conditions. This supply, however, is limited and an emergency raw water intake is sometimes used. The sand over the crib is cleaned two or three times a year, between May and December. During the five winter and spring months no cleaning operations are undertaken.

The water is pumped to Reservoir No. 1, which is back one mile from the river and on the highest hill in the vicinity. The elevation of the water in this basin is 563 feet. It is used for storage of filtered water. The filters were built during 1909 and since July 1910, the entire supply has been filtered. The purification plant is located adjacent to this reservoir. Four miles distant is Reservoir No. 2, there being a forty-two inch main connecting these basins. Reservoir No. 1 is an earth embankment structure, concrete-lined, and having a capacity when full of 9,150,000 gallons. The depth of water is twenty-one feet. Reservoir No. 2 is sixty-eight feet lower and when full to a depth of twenty feet contains 11,500,000 gallons. It is of similar construction to No. 1. Reservoir No. 3, holding 5,000,000 gallons, is at Port Perry, near East Pittsburgh, and Reservoir No. 4 is up the valley of Turtle Creek, near Pitcairn. The distance traversed by the mains of the water company from the river to Pitcairn borough is approximately eleven miles and the distributing system aggregates about 140 miles of pipe.

During the last half of the year 1905 and the spring of 1906, there was an epidemic of typhoid fever in the water district. Prior to and subsequent to this time the territory was free from the disease in

epidemic form and freer from typhoid cases than the adjacent territory supplied by the city of Pittsburgh system. The following table shows the number of cases in the water company's district:

TABLE LXIX.

Typhoid Fever Cases in the Pennsylvania Water Company District, 1905—1912, inclusive.

Town.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
Wilkinsburg,	157	377	70	56	71	28	19	14
Edgewood,	12	29	5	6	2	0	3	1
Swissvale,	1	140	41	9	10	13	2	5
Rankin,		63	10	5	3	13	6	4
N. Braddock,		123	66	25	15	21	35	31
E. Pittsburgh,			74	21	6	9	4	11
Turtle Creek,	15	15	17	8	4	5	6	2
Wilmerding,	4	36	7	16	12	0	2	2
Pitcairn,	6	40	12	6	5	7	45	9
Trafford City,	5	10	6	3	3	2	5	0
13th Ward, Pittsburgh,	140	286	54	24	34	21	7	15
	340	1,118	362	179	165	119	134	94

Although in 1902 there had been a case of discoloration of the water at the Nadine pumping station, and the company employed a diver who was engaged for many weeks in examining the intake pipes and the crib to discover the leak or cause of turbidity, not until the spring of 1906, was the real cause discovered and remedied, and this was after the epidemic. During the intervening years the open joint in the forty-two inch intake pipe and the holes in the wooden plug at the gate on the twenty-four inch pipe at the old crib had been delivering water, probably into the forty-two inch pipe and constantly into the twenty-four inch pipe. Nevertheless, the analyses of the water did not reveal the pollution as much as the color in the water; and besides there was a comparatively low typhoid rate among the water consumers. During 1904, when the ice gorge carried away the top of the manhole and muddy river water got into the water works system in large quantities, an epidemic did not follow. The outbreak of typhoid began in July 1906 and gradually increased until November when the rate increased rapidly reaching its maximum in April. Sedimentation is an effective barrier to the spread of typhoid infection. The typhoid rates did not drop off until after reservoir No. 1 was used as a sedimentation basin. During the epidemic and also prior to that time the filter crib water was pumped directly into the distributing system. Reservoir No. 1 was used as an equalizer, that is it received the surplus water only. During some hours of the day no water may have flowed in but to the contrary water may have been drawn out of the reservoir; but at night when the consumption fell off in the towns, the surplus pump-

age would fill up the reservoir. The forty-two inch connection was not made to the reservoir until the new pumping engine was installed. This was in the summer of 1905. In November of that year the improvements were completed and since then reservoir No. 1 was used as a sedimentation basin, no water being by-passed around it to the consumers. The State Department of Health took up with the Pennsylvania Water Company the question of treating the water with a germicide. The Department also advised the installation of water filters. The borough of Wilkesburg entered complaint in the court of Common Pleas of Allegheny County against the water company and this action broke off the negotiations between the State Department of Health and the water company. The court found that the water furnished by the company was not pure and wholesome and on September 28th, 1907 the company was ordered to secure and provide either by change of its source of supply, by proper filtration, or by some other proper method, a sufficient supply of water so free from sewage and organic matter, turbidity and odor as to make said water reasonably pure and wholesome. The water company proceeded to prepare plans for a mechanical filtration plant to be located on the north side of reservoir No. 1 and to have a daily capacity of 10,000,000 gallons. In a permit approving these plans issued by the Commissioner of Health on May 5th, 1909 the following statements were made:

"It appears that the water company has charter rights within the territory mentioned in its application.

"There can be no doubt as to the efficiency of the proposed filtration plant from the basis of the design. A much less elaborate layout might suffice to render the filter crib water safe from pathogenic pollution. In anticipation of possible deterioration in the efficiency of the preliminary treatment of the Allegheny River water at the filter cribs and the possible accidental or emergency introduction of the dangerous raw river water into the water works system, the company purposes to provide an adequate remedy against all suspicion at any time of the purity of the water furnished to its consumers.

"From the standpoint of public health it does not appear that the purification plant proposed differs in kind and cost from that installed in a number of places in Pennsylvania and elsewhere. And as soon as it may become necessary to introduce raw river water to the purification plant, nothing less than the arrangement now proposed would warrant approval by the State Department of Health. The feature peculiar to this water works system is the preliminary treatment at the filter crib, which preliminary treatment at the present time as evidenced by the bacteriological analyses hereinbefore given, is so very efficacious as to raise a doubt relative to the expediency of a large expenditure of money to further safeguard the public health. The answer is found in the fact that no apparatus existing for the purpose of removing deadly poisons from water should be beyond ready regulation and control.

"The art of water purification has been developed to the extent hereinbefore set forth in detail whereby various appliances and arrangements are provided throughout the several parts of the plant to admit of ready regulation and control. The mere fact of the inaccessibility of the filter cribs argues against dependence upon them. Accident to the cribs or the piping or the intake chamber or any of the apparatus submerged or liable to be reached by the raw river water might admit sewage pollution to the water works system and endanger public health.

"The gradual discontinuance of the discharge of sewage into the Allegheny River is resulting from the administration of the law to preserve the purity of the waters of the State for the protection of public health. But the river when relieved of its grosser pollutions can never be a safe source of raw water supply. The water must be adequately treated by the corporations which furnish it for domestic use.

"Furthermore, the proposed filter plant when built may break down. The Butler typhoid fever epidemic and the epidemic at Royersford and Spring City were due to the shut down for repairs and the overtaking of the filters whereby the poisons in the source of supply were introduced into the homes of the consumers. The Pennsylvania Water Company has provision made in the plans hereinbefore described, for the by-passing of the raw river water around the filters and the storage reservoir to the district. An emergency might arise at any moment when this might have to be done, or the water district would be without a supply, hence the necessity of preserving the purity of the Allegheny River water as far as this may be practical. Both diminution in the pollution of the source and effective purification of the water by the user is demanded. The water company should continue the use of the filter cribs as a double safeguard, especially during the early years of the campaign of the Commonwealth against sewage pollution of drinking water.

"The Port Perry Station on the Monongahela River should be immediately abandoned and disconnected after the filter plant and the raw water emergency inlet at the intake chamber on the shores of the Allegheny River have been built. The latter emergency should not be built prior to the erection of the filter plant.

"The by-passing of unfiltered water into the reservoir or directly to the consumers should not be done except in a great emergency. In this event the State and local health authorities should be notified immediately.

"Filtered water sometimes deteriorates in quality when it is stored in open reservoirs. Organisms, non-pathogenic, may find favorable conditions for development and discolor and impart a disagreeable taste and odor to the water. It is known that ample circulation retards such development and may prevent it. The treatment of the water so affected is quite effective through the use of chemicals which precipitate and destroy the organisms. It is best to have facilities in a storage reservoir for the drawing off of the water to be consumed at or near the surface at a predetermined depth controlled by will. The water company should give this feature some consideration and adopt and put these suggestions into practice at the earliest practicable moment. Furthermore, it would appear that facilities may be needed in reservoir No. 1 to promote a good circulation of the water."

(c) *Typhoid Fever.* In Table LXX are given data relative to typhoid fever cases occurring in the boroughs along the Allegheny River in the section between the Kiskiminetas River and the Pittsburgh water works intake at Brilliant or Aspinwall. Included in this table are typhoid fever cases in the city of Pittsburgh and in the Pennsylvania Water Company district:

TABLE LXX.

Typhoid Fever Cases in Towns along the Lower Allegheny River, 1906-1912, inclusive.

Town.	1906.	1907.	1908.	1909.	1910.	1911.	1912.
Freeport,	29	250	15	11	26	15	7
Worthington,	0	1	0	4	3	0	1
Brackenridge,	125	50	0	7	13	24	12
Oakmont,	153	86	21	12	11	8	23
Tarentum,	153	86	9	15	28	73	47
Verona,	8	28	6	8	3	2	2
Cheswick,	0	0	0	2	0	0	0
Springdale,	0	0	0	0	0	2	2
Arnold,	9	21	5	4	10	6	8
New Kensington,	44	30	27	15	34	30	44
Parnassus,	5	5	1	1	12	7	8
Natrona,	110	71	0	0	0	0	0
Allegheny City Home,	10	1	0	0	0	0	0
Pittsburgh City Farm,	20	9	0	0	0	0	0
Pennsylvania Water Co. District,	1,118	362	179	165	119	134	94
Pittsburgh,	6,518	5,278	1,714	749	821	639	323

The 125 cases in Brackenridge in the 1906 column really represents some cases that occurred in 1905 during the epidemic of that winter. The 250 cases at Freeport for 1907 are estimated.

It will be noted that typhoid fever has been more extensive in the lower portion of the Allegheny River basin. It is here that more persons live and more persons use the water from the river and this water is the drainage of the entire basin.

PART V

POLLUTION OF THE ALLEGHENY RIVER, EXTENT AND EFFECTS. CONCLUSIONS.

Section 1.—Population.

In Table LXXI are given the names of the principal towns along the Allegheny River, the population and distance in miles above the river's mouth beginning at the source and coming down stream:

TABLE LXXI.

Principal Cities and Towns along the Allegheny River.

Name.	Distance Above Mouth in Miles.	Population 1919.
Coudersport,	301	2,100
Port Allegany,	285	1,980
Eldred,	269	1,240
Olean, N. Y.,	254	14,750
Allegheny, N. Y.,	251	1,250
Salamanca, N. Y.,	233	5,800
Warren,	192	11,086
Tidioute,	170	1,300
Oil City,	134	15,700
Franklin,	127	9,800
Emonton,	92	1,110
Parker,	85	1,240
East Brady,	71	1,500
Kittanning,	46	4,300
Ford City,	43	4,300
Freeport,	30	2,250
Tarentum,	22	7,400
New Kensington,	18	7,700
Springdale,	17	2,000
Oakmont,	12	3,440
Verona,	11	2,850
Aspinwall,	7	2,580
Sharpsburg,	6	8,150
Etna,	5	5,820
Millvale,	4	7,860
Pittsburgh,	0	533,900

In Table LXXII the urban and rural populations are given for the Allegheny River basin. They were determined for the year 1909 by the sub-divisions according to drainage areas. The upper part of the basin is taken first and the populations are given both local and cumulative as progress is made down stream.

It will appear from this table that excluding Pittsburgh and the territory supplied by the Pennsylvania Water Company, that there are in round numbers a million persons living on the basin and about equally divided between those residing in the towns and those residing in the rural district.

TABLE LXXII.

Urban and Rural Populations, 1909, in the Allegheny River Basin by Sections.

Territory.	Urban.		Rural.		Total.	
	Local.	Cumul.	Local.	Cumul.	Local.	Cumul.
River above Potato Creek,	8,390	.....	7,686	.....	16,076	.....
Potato Creek,	2,000	10,390	5,550	13,236	7,550	23,590
River to Oswayo Creek,	1,800	12,190	3,600	16,836	5,400	28,990
Oswayo Creek,	3,600	15,790	4,610	21,446	8,210	37,230
River to Tunungawant Creek,	22,020	37,810	14,406	35,852	36,426	73,650
Tunungawant Creek,	18,220	56,030	6,190	42,042	24,410	98,060
River to State Line,	9,830	65,860	840	50,670	17,870	114,930
River below State Line,	11,300	77,160	9,440	59,510	20,740	136,670
Conewango Creek,	44,870	122,030	28,240	87,750	73,110	209,780
River to Brokenstraw Creek,	11,000	133,030	1,690	89,440	12,690	222,470
Brokenstraw Creek,	9,780	142,810	9,170	98,610	18,950	241,420
River to Tionesta Creek,	2,150	144,960	4,850	103,460	7,000	248,420
Tionesta Creek,	4,200	149,160	7,460	110,920	11,660	260,080
River to Oil Creek,	2,100	151,260	3,510	114,430	5,610	265,690
Oil Creek,	12,800	164,060	9,100	123,530	21,900	286,590
River to French Creek,	15,500	179,560	2,480	126,010	17,980	304,570
French Creek,	29,060	208,620	43,760	169,770	72,820	378,390
River to Clarion River,	16,390	225,010	16,760	186,530	33,150	411,540
Clarion River,	25,790	250,800	41,320	227,850	67,110	478,650
River to Red Bank Creek,	4,240	255,040	6,340	234,190	10,580	488,230
Red Bank Creek,	29,110	284,150	32,650	266,840	61,760	550,990
River to Mahoning Creek, .....	.....	284,150	1,550	268,390	1,550	552,540
Mahoning Creek,	27,200	311,350	17,500	285,890	44,700	597,310
River to Crooked Creek,	14,980	326,330	9,890	295,780	24,870	622,280
Crooked Creek,	3,260	329,590	9,110	304,890	12,370	634,650
River to Kiskiminetas River,	800	330,390	2,940	307,830	3,740	638,390
Kiskiminetas River,	158,570	488,960	80,700	388,530	239,270	877,550
River below Kiskiminetas River, ..	38,500	520,910	21,250	409,780	60,200	937,550
Total,	520,910	.....	409,950	.....	937,860	.....

Section 2.—Pollution Summary.

Of course along the streams that receive the sewage from the town sewers the added pollution that comes from railroad operations may not be material; but on up-land watersheds such pollutions may be an important menace. As stated elsewhere the Allegheny River watershed is traversed by railroads aggregating over 2,500 miles in length. The tracks are laid in close proximity to the river or its tributaries. There are approximately 7,000 passengers and employees constantly travelling on the trains. There are also about 400 men continuously at work along the tracks. The fact that patients recovering from typhoid often travel on trains as soon as they are able and the fact that a good many of these patients are probable "carriers" of the infection taken in connection with the present method of disposal of sewage from passenger coaches makes it necessary to consider this class of pollution.

We have seen that in addition to sewage pollution, pollution of the State waters in the basin occurs at tanneries, chemical plants, coal mines, oil wells, and refineries. Some of the effects produced by these polluting agencies are here briefly noted.

At the head waters of the river, above Potato Creek, frequent complaints are made that the fish have been exterminated and that cattle are made sick on account of the discharges of wastes from tanneries and chemical plants into natural water courses. These pollutions produce a visible effect on the water at Port Allegany, and the creosote taste and odor nuisance are a live topic at Warren, where the public supply is made less desirable on this account.

Oswayo Creek watershed contains no sewerage systems, tanneries, nor chemical plants or coal mines, and the water is constantly pure and clear.

French Creek is polluted by a considerable population and a tannery. But it has a succession of pools and shoals affording sedimentation and aeration, so that the water appears desirable for a supply near Franklin city.

The West Branch of the Clarion River is a clear stream above the tanneries and chemical plants; but below them the waters are foul, discolored, and objectionable. Elk Creek which enters the Clarion River at Ridgway discharges a black water due to pollutions from tannery wastes and chemical plants and coal mines. Little Toby Creek, a tributary, is stained yellow with mine drainage. Fish in the Clarion River have been destroyed in great numbers by these agencies.

Red Bank Creek is badly stained with mine wastes and Mahoning Creek also has the characteristics of water that receives large quantities of mine drainage.

In the Kiskiminetas River sub-basin several of the streams are discolored by wastes from mines and cokeries. The effect is clearly visible in the lower reaches of the Kiskiminetas river.

The harm that oil wastes do will be explained under the Pittsburgh water supply.

TABLE LXXIII.

Summary of Polluting Factors on the Allegheny Basin, by Sections.

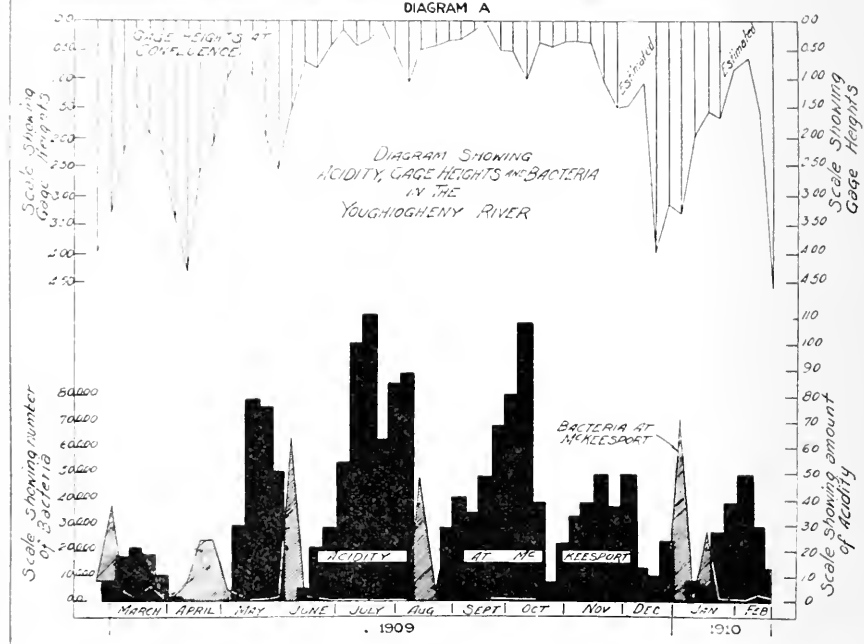
Stream.	Sewage Polluting Population.	Tanning Plants.	Chemical Plants.	Coal Mines.
Allegheny River,	5,760	2	5	.....
Potato Creek,	959	0	5	.....
Allegheny River,	790	1	1	.....
Oswayo Creek,	1,620	0	1	.....
Allegheny River,	16,800	5	0	.....
Tunungawant Creek,	2,469	1	7	.....
Allegheny River and Kinzua Creek,	11,800	4	12	.....
Conewango Creek,	53,230	0	0	.....
Allegheny River,	8,170	0	0	.....
Brokenstraw Creek,	7,630	2	0	.....
Allegheny River,	775	1	0	.....
Tionesta Creek,	3,070	7	3	.....
Allegheny River,	1,930	0	0	.....
Oil Creek,	8,165	1	0	.....
Allegheny River,	10,375	0	0	.....
French Creek,	24,335	1	0	.....
Allegheny River,	12,320	0	0	.....
Clarion River,	25,825	8	11	58
Allegheny River,	4,000	0	0	29
Red Bank Creek,	27,690	2	0	77
Allegheny River,	230	0	0	4
Mahoning Creek,	12,910	1	0	74
Allegheny River,	13,530	0	0	20
Crooked Creek,	2,945	0	0	20
Allegheny River,	1,240	0	0	9
Kiskiminetas River,	144,415	0	1	382
Allegheny River to Brilliant,	38,335	0	1	39
Totals,	421,270	37	47	722

In Table LXXIII the sewage polluting population on the streams is given in figures as ascertained at the time the sanitary inspectors of the Department first visited the water sheds in the prosecution of their regular duties. A great many abatements have been effected since then, more especially on the watersheds that yield supplies used for domestic purposes. In the proximity to towns whose sewage goes into the river or tributaries, the population may continue to contribute some pollution. The State Department of Health's judgment has been exercised in these cases. In agricultural pursuits the fertilizing of the soil contributes a polluting factor when the rains scour some of the manure to streams. The surface drainage from streets in towns is an unpreventable pollution. The freshet waters from the basin bring down the washings from the entire area and at such times the water in the Allegheny River at Pittsburgh contains high counts of bacteria. This will always be true on an inhabited watershed.

Section 3.—Mine Drainage as a Purifying Agency.

A false sense of security is possessed by the people generally in the belief that the presence of mine drainage in a stream insures sterility and renders the water safe for drinking purposes without filtra-

DIAGRAM A



tion. There is no doubt that the water discharged from coal mines has a germicidal effect upon the stream receiving it; but the extent of the action is uncertain. The amount of drainage pumped from a given mine, its acid content, the total drainage from all the mines above the point in question, the volume of the stream and its character, and the extent of other pollutions, as will be shown below, are all variable quantities that affect the potability and desirability of stream water as a source of municipal supply.

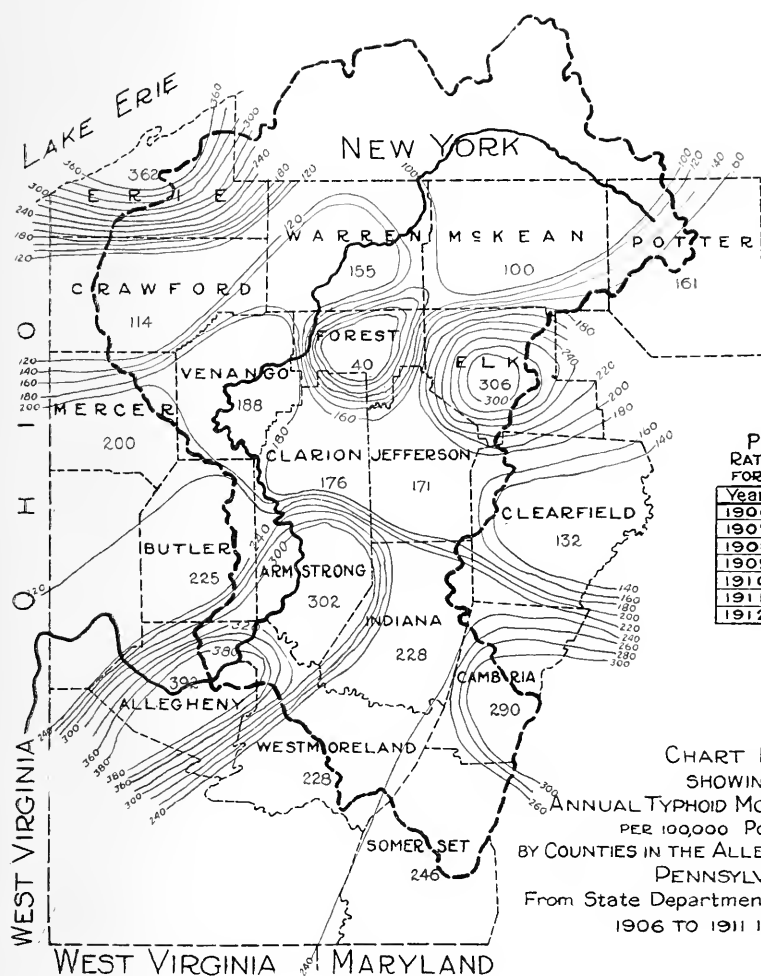
Mine drainage, coking operations, and iron works waste are usually the sources of acid pollution. Generally the amount of the acid is rather constant when the works are in operation and so, when the flow of the stream is constant and the amount of acid entering the stream varies but little, there is considerable reduction in bacterial content. The flow of any stream, however, is irregular, and hence even if the discharge of acid into the stream were constant, there would be a great variation in the acidity of the stream and hence in the bacterial content of the water, depending largely upon the amount of flow of the stream. It is known that high water lowers the acidity and is accompanied by an increase in bacteria, while a low water stage is accompanied by an increase in acidity and a consequent reduction in bacteria.

The city of McKeesport has a water treatment plant located on the Youghiogheny River. Here daily chemical and bacteriological analyses are made of the raw and filtered water. From the data obtained here Diagram A has been prepared and is presented to show the relation of the acidity and the bacterial content of the river water at McKeesport, and the height of the water in the Youghiogheny River at Confluence sixty miles up stream. The water height at Confluence is taken for convenience as representing the stage of the river and as typical of the relative yield of the watershed at McKeesport. The diagram covers a period of one year between February, 1909, and February, 1910. It will be noted that the acidity of the river at times is so high as to render the raw water nearly sterile. The height of the water flow line changes almost every day. The acid line and the bacterial line are more constant. This may be due partly to the fact that the gauge readings at Confluence were taken in a free flowing stream while the acid and bacterial samples were taken from the river at the water works intake where the flow is affected by a dam and pool, the large body of water tending to keep the acid and bacterial quantities more uniform. Furthermore it will be noted that the acid and bacterial lines vary and that this variation follows the variations in the water flow line. A rise in the flow of the river causes a reduction in the acidity. With the rise in the riverflow, comes an increase in bacteria. The diagram shows clearly how the acid varies and that it cannot be depended

upon always to reduce the bacteria. For instance, as the diagram shows, when the acid reaches 100 parts in a million the bacterial content is almost zero, but a short time before, when the river rose, the water became alkaline and the bacterial count went up suddenly to nearly 100,000. A change in weather conditions may quickly annul the germicidal effect of the acid and at such times it is dangerous to use the stream as a source of public water supply without filtration. Nevertheless, it is undoubtedly true that had it not been for the discharge of drainage from coal mines into the waters of the Allegheny basin, typhoid fever would have been more prevalent than the records indicate for the basin. The Commissioner of Health has announced it to be in the interest of public health that sewage should first be taken from the streams before any general attempt is made to bring about some regulation and control of the discharge of mine drainage into State waters to render them more potable for public uses.

Section 4.—Typhoid Charts.

Statistics of typhoid morbidity are in some instances incomplete and frequently unreliable owing to failure on the part of physicians to report cases. At many places where a special house to house canvas has been made by the Department it has been disclosed that a larger number of cases of typhoid fever had occurred than had been reported to the Bureau of Vital Statistics. The accompanying chart showing annual typhoid morbidity rates for each 100,000 of population by counties, all or partly in the Allegheny River basin, is based chiefly on the records of the Bureau of Vital Statistics of the Department for the years 1906-1911 inclusive. It illustrates in a general way how the occurrence of typhoid is low in the rural districts especially near the head waters and that the disease becomes more prevalent as progress is made down stream into the more populated counties and the urban districts. Contours of equal rates at intervals of 20 cases for each 100,000 population are shown and by these it appears at once that the high typhoid fever rates exist in the lower portion of the basin along the river where the people have to rely upon the sewage polluted waters of the Allegheny for domestic use. It also shows that at Erie and vicinity and at Johnstown and vicinity, two local centres of large population the rates are much higher than in the contiguous counties. Elk County is high because of typhoid fever at Johnsonburg and an epidemic at Ridgway. The chart is practically a summary graphically illustrated

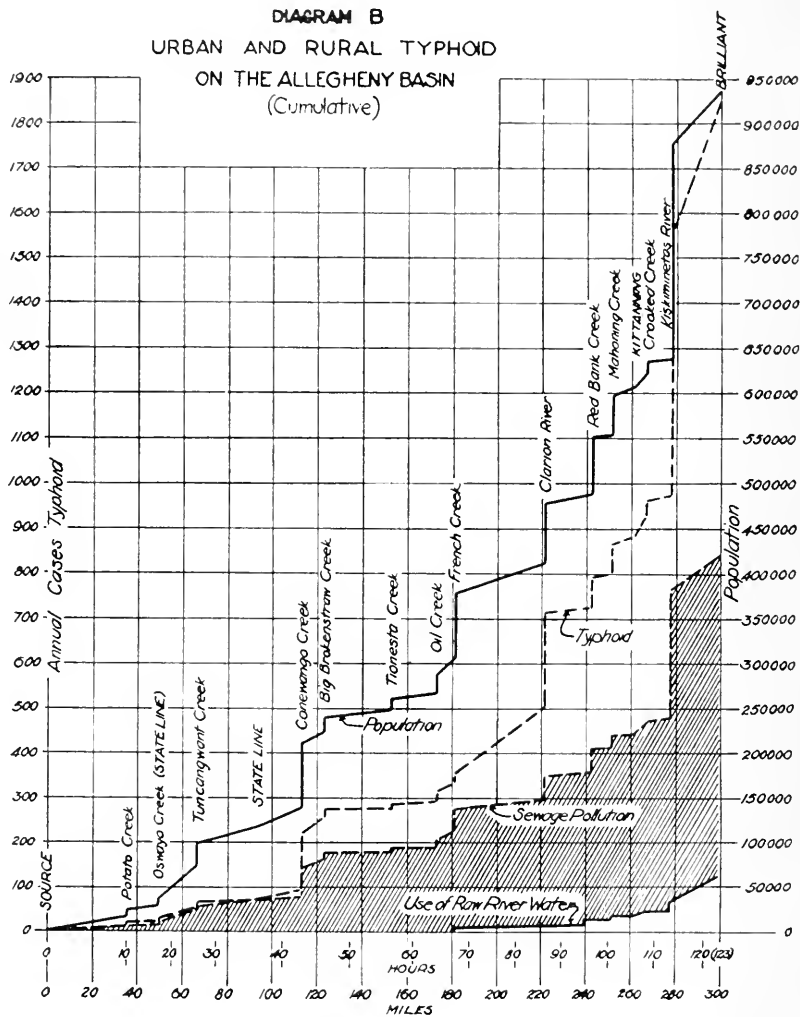


PENNSYLVANIA
RATES PER 100,000
FOR ENTIRE STATE

Year	Deaths	Cases
1906	54.8	313
1907	48.6	286
1908	32.4	211
1909	22.7	164
1910	24.6	185
1911	20.6	152
1912	18.4	

CHART No.5
SHOWING
ANNUAL TYPHOID MORBIDITY RATES
PER 100,000 POPULATION
BY COUNTIES IN THE ALLEGHENY RIVER BASIN
PENNSYLVANIA
From State Department of Health Records
1906 TO 1911 INCLUSIVE

DIAGRAM B
URBAN AND RURAL TYPHOID
ON THE ALLEGHENY BASIN
 (Cumulative)



of the various typhoid fever tables before given supplemented by the typhoid records for the rural districts.

Diagram B has been prepared to illustrate the relation between population, sewage pollution, the use of raw river water, and the occurrence of typhoid fever in the Allegheny River basin. Distances along the river from the source to the mouth, or Brilliant at Pittsburgh, are shown by the horizontal scale. The approximate number of hours required for water to flow from the source to the mouth of the river or to intermediate points is also shown by a horizontal scale. The vertical scales show population and typhoid. The diagram includes both urban and rural records of the disease on the entire watershed above any given point; that is, the average annual cases of typhoid for any given area. It will be noted that at the source there is no typhoid fever, since there is no population while at Brilliant there is a population of 950,000 and 1,850 cases of typhoid fever per annum. It takes 123 hours for the water to flow from the source, the distance being 300 miles. The estimated population is based on census reports modified up to January 1st, 1909. The sewage polluting population is largely based on inspections made by officers of the Department. For urban typhoid the years 1906, 1907 and 1908 were taken and also for rural typhoid. The table is approximately correct up to January 1st, 1909. It will be noted that Pittsburgh is not included.

Section 5.—Pittsburgh Water Supply, Typhoid Fever, Conclusions.

In this section of the report it will be shown how what happens on the watershed of the Allegheny River affects hundreds of thousands of persons living in Pittsburgh and relying on this water for daily use. On August 17th, 1908, the Commissioner of Health issued a decree to the city of Pittsburgh, ordering certain things to be done. In this document the following description of the water works system was given.

(a)—Pittsburgh Water Works in 1908.

"The territory comprising the Greater Pittsburgh District as incorporated in one municipality, now includes 'Old Pittsburgh' or all the land lying east of the confluence of the Allegheny and Monongahela Rivers between the former on the north and the latter on the south, for a distance of about seven miles in which reside approximately 300,000 people; also the 'South Side' or the land along the south bank of the Monongahela River opposite Pittsburgh proper, a stretch of four miles, and westerly along the south bank of the Ohio River for 2.5 miles in which reside approximately 100,000 people; and also the 'North Side' or all the land on the north bank of the Allegheny opposite old Pittsburgh, a stretch of about three miles and westerly along the north bank of the Ohio for about three miles—formerly the city of Allegheny—in which reside approximately 150,000 people.

"Beyond the site described, there are in the immediate vicinity many municipalities which are closely allied with Pittsburgh. Numerous territorial accessions by annexation have been made to Pittsburgh in the past. It was under the provisions of Act No. 162, approved April 20th, 1905, providing 'that where two cities are contiguous and in the same county, the smaller may be annexed to the larger' that Allegheny City was absorbed.

"The annexation idea is predominant and this tendency is of more than passing import.

"Ranking fifth among the cities of the United States in commercial and industrial importance—because it is the port of entry and transfer between the east and west and because it is the largest shipping point for bituminous coal, and because it has the natural fuel supply of coal, coke and gas and the climate, to foster enterprise—no period of its expansion has been more promising than the present. Local problems pertaining to public water supply may with peculiar reason be contemplated in relation to probable consolidation.

"The past conditions of growth offer a partial explanation of the different independent water works systems found existing within the municipal territory of Pittsburgh to-day.

"In 'Old Pittsburgh,' comprising wards 1 to 23, inclusive, Brushton Borough, now 37th Ward, and Sterrett Township, now 41st Ward, there are two systems, one owned by the municipality and the other owned by a private corporation named the Pennsylvania Water Company, authorized to supply water to the public in said borough and township prior to their annexation to the city.

"In the 'South Side' the water is furnished by two private corporations; one being the Monongahela Water Company, supplying Wards 23 to 36, inclusive, and the 39th and 40th Wards (formerly Elliott and Esplen Boroughs), and the other being the South Pittsburgh Water Company supplying Wards 38, 42, 43 and 44, formerly Beltzhoover, Montooth, Sheraden, and West Liberty Boroughs, respectively.

"The Old City of Allegheny, now the 'North Side,' has its own water system.

"Old Pittsburgh Water Supply."

"Taking up each system in the order stated, with respect to the Old Pittsburgh water supply, it is noted that the topography of the city proper is so uneven, elevations ranging over 500 feet, that distinct systems of distribution have resulted. However, all water is primarily lifted into the Highland Park Reservoir from the Brilliant Pumping Station. This plant is located on the south bank of the Allegheny about six miles above the mouth of the river. Formerly the water was drawn directly from the river at this point; now it arrives at the station through pipes connected to the water purification plant located on the opposite bank in O'Hara Township.

"No emergency intake is provided at the Brilliant Station whereby raw water may be admitted to the system.

"The engines comprise four fifteen million gallon pumps, four twelve million gallon pumps and two ten million gallon pumps, equivalent to a combined capacity of one hundred and twenty-eight million gallons per twenty-four hours. Since the maximum daily pumpage is eighty-three million gallons, the reserve of forty-five million gallons is an apparently large margin. The effective margin, taking into account contemplated improvements and additions to the system, is nearer thirty million gallons. The engine room floor is above freshet line; but the boilers are in danger of being put out of commission by an extraordinary flood. Some corrective measures are planned and they are to be applied at an early date.

"Highland Reservoir No. 1 has a storage capacity of one hundred and eighteen million gallons. Reservoir No. 2 has a capacity of one hundred and twenty million gallons. The latter is ninety-one feet lower in elevation. Both are on the hill back from and near the pump house. Both are interchangeable, and both may be cut off and the supply be pumped directly into town.

"River mud at times is excessive. A large proportion of the heavier sediment has in the past been deposited in the reservoir. Some of the fine material found its way on into the street mains. Now that filtered water is being furnished, the city is engaged in cleaning out the service pipes and the reservoir preparatory to keeping them in such condition.

"The distribution districts are divided into a low, high, and extra high service.

"The low service is a gravity supply from reservoir No. 2; but in emergencies or at choice it may be connected to reservoir No. 1. This territory comprises all the lower portion of the city bordering on the Allegheny and Monongahela Rivers—a strip not over one-half mile wide at any place. It includes the manufacturing, mercantile and down-town shopping districts. Probably 110,000 people are served.

"The high service, comprising an extensive area with a resident population of 90,000 people is supplied by gravity from Highland Reservoir No. 1. The district includes the lands too elevated to be properly reached by the low service.

"The extra high service is furnished by water pumped from the high service mains into reservoirs and tanks located at such points and elevations as to serve districts above the reach of the high service system. There are four such services, named in order of importance, Herron, Bedford, Garfield and Lincoln.

"A thirty inch main from reservoir No. 1 feeds the Herron Pumping Station at the corner of Central Avenue and Craig Street in the central part of the city near Shenley Park. From this point the supply is pumped into the reservoir on Herron Hill not far distant, and also by a separate main into the reservoir on Bedford Hill, near the down-town district. The latter basin holds 2.25 million gallons and supplies a mercantile district of about 27,000 population. The former holds eight million gallons and supplies a large residential area of about 47,000 population.

"The Garfield tanks are of steel construction, hold 500,000 gallons and supply about 10,000 people resident near Highland Park. The pumping station is at the corner of Dearborn and Pacific Streets.

"The Lincoln tanks hold 250,000 gallons. They are on the hillside near the east city line. The pump house is located on the corner of Park Avenue and Dean Street. There are resident in the district about 10,000 people.

"About seventy million gallons is the present average daily pumpage at the Brilliant Station.

"Pennsylvania Water Company.

"The population within the city supplied by the Pennsylvania Water Company is about 18,000. All service connections are metered and the estimated consumption is about forty gallons per capita. On the municipal system it is between 230 and 260 gallons.

"The company was chartered in 1887 to supply water in the township of Sterrett, out of which the 37th Ward, formerly Brushton Borough, and the 41st Ward, were made. The plant supplies Wilkinsburg and other places as far south as North Braddock. In 1899 the Pennsylvania Water Company purchased the works of the Turtle Creek Valley Water Company, built to supply the borough in the Turtle Creek Valley and then known as the East Pittsburgh Water Company. The whole territory is now supplied from the pumping station of the Pennsylvania Water Company on the Allegheny River at Nadine. This point is about two miles above the Brilliant Pumping Station.

"The water is taken from three filter cribs built four feet below the bottom of the river bed.

"Crib No. 1 is 308 feet long by 33 feet wide and 5 feet deep. It is covered with gravel and sand.

"Cribs Nos. 2 and 3 are each 408 feet long by 48 feet wide by 5 feet deep, built in the same way, corn crib fashion.

"From No. 1 crib a twenty-four inch cast iron pipe is laid below the bed of the river to a manhole on the south bank of the river. From Cribs Nos. 2 and 3 a forty-two inch cast iron pipe is laid below the bed of the river to the same manhole; thence to the pump there is a six foot tunnel. The bottom of the river over the cribs is not allowed to silt up. This is prevented by dragging over it a rake made of pipe from which water is discharged in small jets under pressure of 100 pounds per square inch. The observed reduction of bacteria in water pumped compared to the raw water is between 90 and 99 per cent. when the cribs are in working order. Occasionally the cribs fall off in efficiency.

"One ten million gallon and one six gallon pumping engine raise the water to a reservoir of six million gallons capacity, located on high ground back of the station and distant therefrom 5,000 feet. About 23,000 feet from reservoir No. 1 is reservoir No. 2, which holds twelve million gallons. They are connected by a forty-two inch pipe. The portion of the city noted, is supplied principally from reservoir No. 1; but Ward 37 may be supplied directly from reservoir No. 2.

"The water furnished by the Pennsylvania Water Company is usually clear. It is generally superior in quality to that furnished by the city prior to the starting up of the Aspinwall filters.

"Monongahela Water Company.

"As stated above, the 'South Side, excepting Wards 38, 42, 43 and 44, is supplied by the Monongahela Water Company. To meet the conditions imposed by broken topography, three services with reservoirs and tanks at different elevations have been installed by the company. They comprise the low district, the Allentown high district, and the Esplen district.

"The larger part of the supply is pumped from the Monongahela River at the main pumping station situated on the river front at the foot of 29th Street. The water is raised into the Birmingham settling basins, open brick-lined structures built in the nearby hillside at the head of 31st Street at the elevation of about 200 feet above the river. These basins have a total capacity of three million gallons and from them the water flows by gravity to the low service area lying between the foot hills and the river.

"The intake is a thirty-six inch pipe run out to the middle of the stream. There is a screen on the end of it. The power plant is subject to inundation. The pumps are not in first class order. There are five of them, one being four million, two being ten million and two being five million gallons capacity. The latter raise water 598 feet high through a twenty inch line into three settling basins, each sixty feet in diameter by forty feet high, located in the 27th Ward on the highest ground available in the Allentown district. Thirty-eight thousand people reside in the hill area—Wards 27, 31, 32 and 35—served by these tanks.

"A sub-station, of not much account, at the Birmingham basins, is maintained in reserve to pump water through a ten inch pipe and by a cross connection into the twenty inch line to the tanks.

"The Allentown and the low service area comprising Wards 24 to 35, inclusive, and Ward 36 in the Esplen territory, constitute the old district of the 'South Side'. Eighty-three thousand people are now resident therein. The daily consumption, excepting the 26th Ward, approximates twelve million gallons and the water is

delivered through ninety miles of street main. These mains are known to be clogged with mud deposits.

"The new Esplen plant was built by the Monongahela Water Company and put in service in 1895. It is now operated in conjunction with the 'Old District' works. Besides Ward 36, it includes the 39th and 40th Wards (formerly Elliott and Esplen boroughs), and outside of the city, part of the borough of McKees Rocks and parts of Chartiers and Stowe townships.

"The water is pumped from the Ohio River at a point opposite Brunot's Island. There are two filter cribs here sunk in the river bed from each of which a twenty-four inch supply pipe leads to wells in the station. There are also fourteen twelve inch drilled wells; each about fifty feet deep, from which water is drawn. The supply is lifted by two pumping engines, each three million gallons capacity, a vertical height of 425 feet to two steel tanks, each fifty feet in diameter and seventy feet high, located on Sheraden Hill, from whence the discharge is by gravity to the district. Ward 36 contains about 4,000 people.

"The superiority of the plants under municipal control in Pittsburgh proper as compared with private ownership on the 'South Side', above described, is particularly conspicuous in every detail of design, management and maintenance, and is one reason for popular sentiment favorable to city ownership.

"In December, 1906, the city petitioned for appraisement of the value of the plant and property of the Monongahela Water Company lying in Wards 24 to 36, inclusive, since these were the city limits in 1885, when an agreement was entered into between the city and the water company, whereby the latter obtained an exclusive franchise for twenty-one years to the said territory of thirteen wards.

"The company does not now own any pipes outside of the 24th and 36th wards, inclusive, excepting the pipe system connected with the Esplen plant which lies largely outside the limits of the city. All others were purchased by the Chartiers Valley Water Company in 1896.

"So the Monongahela Water Company will continue to exercise its franchises outside the 'Old District' but still within Pittsburgh's limits subsequent to any purchase of the 'Old District' plant by the city.

"In fixing upon a fair value for the plant to be purchased, the water company's experts have frankly admitted that improvements are advisable and necessary and would be made by any private individual accustomed to successful management of water works property. The quality of the water must be improved by filtration. The company's plans proposed as a basis for estimation of cost of giving good service is to locate a fifteen million gallon filter plant at the Birmingham reservoir, build settling basins of approved type out of one of the existing basins and use the other to store filtered water; erect two new vertical pumps at the 29th Street Station to pump all the water needed from the river to the settling basins; provide a return pipe to remodeled high district pumps for delivery of filtered water to Allentown tanks; build a new pump house and plant at the reservoir; raise up and alter the main station; clean out all street pipes; re-build intakes, and in fact, re-vamp the entire system to secure an up-to-date service.

"At the present time there is no competition whatever in the supply of water in the district. There is a contract existing between the Monongahela Water and the South Pittsburgh Water Company, the only other concern supplying water to adjacent territory, whereby these two companies refrain from entering into competition. This should operate to the benefit of the service at once in the Esplen district and also in the thirteen wards in event of the failure of the city to acquire the latter works.

"It is the city's plan to supply filtered water should the 'South Side' plant come under municipal control. The obligation of the water company is equally as great at all times to supply pure water at reasonable rates, subject to the regulation of the court.

"South Pittsburgh Water Company."

"The South Pittsburgh Water plant comprises a pumping station on the Monongahela River at Beck's Run, about one mile up-stream from the 29th Street Station of the Monongahela Water Company, a buried filter crib in the river bed and two auxiliary pipe lines leading directly from the stream into the pump well, a mechanical filter plant including settling tanks, filters, clear water basin, chemical laboratories and all appurtenances of latest and most approved pattern, three five million gallon service pumps at the filter plant to raise the water into a steel tank on the hill in Mt. Oliver borough and a system of distributing mains reaching a large population in the municipalities bordering the Pittsburgh boundary and in the townships beyond. It also serves the four hill wards of the city above mentioned. The works are managed with exemplary care under skilled direction. The water is clear and pure and the service is eminently satisfactory. This feature has materially aided in the building up of the district. A contract exists between the city and the company for fire hydrant service. All the territory covered by this water company and by the Pennsylvania Water Company will in all likelihood be annexed to Pittsburgh and following there is likely to be agitation for municipal control of the water works. Naturally city ownership would effect alterations in methods of distribution. Such possibility need only be thought of in considering the present question of supplying filtered water to the north and south sides of Pittsburgh as at present incorporated.

"The 'North Side', formerly Allegheny City, is supplied entirely from water works owned and operated by the municipality and like the other parts of Pittsburgh, the topography is irregular, ranging 600 feet or more in elevation so that there are several systems of distribution.

"The supply is taken from the Allegheny River at two points. At Montrose village in O'Hara Township, opposite Verona, 9.5 miles up-stream, is the principal pumping station. An auxiliary plant called River Avenue Station is in the eastern part of the 'North Side' at the site of the original pump house built in 1849.

"The Montrose intake has a timber crib 2,500 feet long by 32 feet wide by 7 feet deep, placed in a trench excavation in the river bottom. It is planked on top and covered with gravel to original surface of the channel and its sides are rippaped filling. Difficulty has been experienced in keeping the structure open to admit of the passage of water. The sides have been dredged out for this purpose; but they fill up again. So far as keeping out silt from the pump chambers or clarifying the river water goes the crib may as well be out of commission.

"There are two fifteen million gallon triple expansion pumping engines and three twelve million gallon cross compound pumping engines in the station. They raise about forty million gallons of water daily a vertical height of 247 feet through a sixty inch steel force main 9.5 miles long to Troy Hill Reservoir, where the water is delivered directly into the low service district without going into the reservoir. The surplus overflows into duplicate basins at said reservoir. The two large pumps are new. They were put in final commission early in the current year. Now all the supply is pumped at the Montrose Station; but prior to 1907, for ten years or so, about one-third of the water supply was drawn from the river at the River Avenue Station. Steam in one battery of boilers is still kept up at this old station in readiness for use during emergencies.

"Here the intakes are two twenty-four inch and one thirty-six inch pipe. They extend down stream for fifty-six feet and are perforated with one inch holes. The plant is subject to possible interruption of service at times of extreme high water. A combined rated capacity of thirty-three million gallons is afforded by the five pumps. They are in poor condition. The water is raised to Troy Hill Reservoir near by.

"The Troy Hill Reservoir holds 7,500,000 gallons. It is of earth embankment construction, concrete lined and paved with brick. A wall divides the reservoir into two basins of about equal capacity. Each is in poor condition, especially at the frost line.

"From Troy Hill Reservoir the water was formerly furnished by gravity to the low service district comprising a belt of varying width extending nearly the whole length of the river front. The section includes all the manufacturing and commercial districts and covers an area of about 2.5 square miles. The population served approximates 95,000 people; not only the low but the several distinct high services draw water from the basins. A thirty inch and sixteen inch gravity main extends northeast about a mile to the Howard Street pumping station which is located at the corner of Howard and Rising Main Streets. Here five pumping engines raise the water into tanks into districts B, C, and D. Each tank is forty feet in diameter and twenty-two feet high.

"There is one eight million and one five million triple expansion pumping engine and one three million and two two million and a half gallon pumping engines of the combined duplex type in the station.

"A twenty-four inch main leads to two tanks on Nunnery Hill near by. They are elevated 288 feet above the Troy Reservoir. From them a residential area of one square mile lying directly north of the low service district and comprising 20,000 people is supplied by a gravity flow. This is high service district B.

"A separate twenty-four inch main also leads to two tanks located eighty-five feet higher on Nunnery Hill which feed district C, an area of 2.7 square miles extending to the northerly city boundary and containing an approximate population of 20,000 people.

"An irregular shaped area of 1.2 square miles adjacent to the eastern boundary of the city, containing a population of about 10,000 people, comprises high service district D. It is fed from two tanks on Spring Hill. A sixteen inch force main from the Howard Street Station delivers water into these tanks. They are elevated about 369 feet above the Troy Reservoir.

"In district C at the city line is Green Tree Hill, the highest land in Allegheny County. On this eminence are two tanks supplied with water from an auxiliary pumping station on Broadway. The tanks feed a local extra high area of about two-tenths square miles. The pumps are electrically driven and have a capacity of one million gallons each. The consumption is small.

"At the Troy Hill Reservoir is a pumping station containing two pumps, rated capacity 1,000,000 gallons each, which supply by direct pressure a district of about three tenths square miles on the hill land in the vicinity.

"The investigator must be struck with the lack in the water works of opportunity for sedimentation. Troy Hill Reservoir has too little capacity to assure the removal of silt. Water of the quality of the Allegheny River, if delivered into the system without sedimentation or purification, is bound to clog up the pipes and house con-

nections and reduce the efficiency of the works and hence increase the cost of operation and maintenance. These matters are indirectly prejudicial to the public health.

"Water Purification Plant.

"Plans for a complete purification plant to furnish all of the city of Pittsburgh, including the 'South Side' with pure water were adopted and the construction work begun in 1905.

"Opposite the Brilliant Pumping Station and just above it on the north bank of the river is a level plateau over a mile long and about half a mile wide whose elevation is higher than the highest freshet ever recorded. Here a slow sand filtration plant has been erected, consisting of a pumping station, sedimentation basins, forty-six acres of covered filter beds, each an acre in area, covered filtered water basin and gravity supply mains under the river to the pump wells in the Brilliant Station. The net daily capacity of the filters is one hundred million gallons based on a maximum rate of filtration of three million gallons per acre per 24 hours, making allowance for cleaning and other operations. The works were designed for future additions, space having been reserved therefor in the eastern portion of the tract owned by the city.

"The site is in O'Hara Township, bounded on the west by Aspinwall borough. At the upper end of the said tract are the new intakes and pumping station called Ross Station. The capacity is between 140 million and 180 million gallons per 24 hours, dependent on the height of the river water. These engines raise the raw water into the central receiving basin, capacity twenty million gallons, on either side of which are larger sedimentation basins, capacity sixty million gallons each, from which the water passes to the filters.

"The heavier suspended matters deposit in the primary receiving basin. All three basins are designed to drain to sumps leading to the drainage system of the plant.

"The conduits carrying settled water from the basins lead to the central gate chamber at the primary receiving basin. The operation of the entire plant is controlled and directed at the administration building, erected over the central gate chamber. Here are the offices, rooms, operating mechanism and bacteriological and chemical laboratories.

"The sedimentation basins are at the foot of the hill. The filters lie between them and Freeport road and the tracks of the West Penn Division of the Pennsylvania Railroad near the river bank.

"Passing through the site of the filters is a right-of-way in which the sixty inch Montrose Station force main to the Troy Hill Reservoir extends. This strip, sixteen feet wide, is laid out as a driveway and divides the filter layout into north and south parts, three rows of filters being in each part. The distribution and collection system of pipes run at right angles to the driveway. The pipes are housed in covered galleries thirty-one feet wide in the clear, placed between alternate rows of filters. There are four of them, each about 1,000 feet long, including the north and south part, and they contain all auxiliary apparatus and machinery for scraping, washing and restoring sand.

"There is a fan heating and ventilating system in each gallery to maintain a uniform temperature, also an attendant's room. A toilet room and locker and lunch room are provided in each half gallery. The floors of all these places are made tight and arranged for ready cleaning.

"Two sand washing tanks of concrete are placed in each half gallery. The flow of dirty water from the outlet weir of these washers passes directly into the drain. All the drainage is intercepted by a large main trunk drain along Freeport road, which empties into the river opposite gallery number one.

"Adequate facilities for the treatment and disposal of the sewage created at the water filtration plant have been provided. Approval, according to law, was given in a permit issued by the Commissioner of Health under date of April 29, 1907.

"The filter beds have groined concrete floors and covers. The latter are carried on concrete piers fourteen feet on centres. The gravel underdrains total one foot in thickness, the sizes ranging from five to one and a half inches in diameter. The sand layer is between two and four feet deep. The underdrainage system consists of a concrete main collector extending the length of the filter in the longitudinal centre bay and a lateral drain six to eighteen inches in diameter in each transverse bay connects to this main collector. The latter has pipe connection to its corresponding regulating chamber, located in the gallery.

"An automatic recording gauge, indicating the rate of filtration, loss of head and the depth of water over the sand, is supplied for each filter. The facilities for back-flooding the beds and for draining them and for the ordinary feed, are ample. Sand scraping and sand restoring machinery are used. However, the design permits of this work being done by hand were it necessary for any reason.

"The filtered water conduit in each gallery connects with the main conduit ten feet four inches in diameter, extending to the filtered water reservoir. This structure is built of concrete, groin arched, width at one end 294 feet, with a total length between the ends of 1,194 feet, and holding forty-two million gallons. The roof is supported by piers twenty-one and a half feet high, spaced eighteen feet apart on centres. The up-stream end is in line with the down-stream gallery of the filters.

"The river side of the reservoir is nearly parallel and 125 feet from the harbor line. Here an embankment has been filled in on a slope of two to one. The slope is protected up to the elevation of extreme floods with a heavy concrete revetment. A level berm twenty to forty feet in width is carried back from the top of the revetment to a second slope, rising to the level of the filling over the reservoir roof. Tile drainage and puddle cover have been provided to prevent percolation of surface waters into the filtered water basin.

"There is an inlet and outlet chamber at the reservoir. An eighty-four inch by-pass, laid on the reservoir floor, connects the two. The inflow may be measured by weir apparatus. The outflow is through two seventy-two inch pipes, laid under the river to the pumping station at Brilliant. A place for a third seventy-two inch pipe has been left. A Venturi meter is set up in each seventy-two inch pipe. This is the last of four measuring stations by which the quantity of water flowing from various parts of the plant may be observed and loss located.

"In connection with distributing filtered water a fifty inch pipe line has been laid from Highland Reservoir to a point on the north side of the Monongahela River, a distance of about five miles, and thence under the river by a thirty-six inch pipe, to supply the 'South Side'. The thirty-six inch main connects at 29th Street with the system of the Monongahela Water Company, but water is not furnished, but might be in an emergency.

"The general idea of the landscape treatment of the entire water filter layout is to isolate the site from surroundings by hedges and seed down the entire enclosure, lay out drives around and by the sedimentation basins, pump house and filters and reduce the formality of the view by shrubbery and small trees along the drives.

"Three filters were put in commission in December last, seven in January, eight in March, six in April and three in May, and now there are altogether thirty-nine units operated. They are distributed along each of the four galleries. All of the water delivered through the Brilliant pumping station, as previously stated, comes from the purification plant; but not all is filtered. Only forty-one million gallons daily pass through the sand beds. The balance to make up the seventy million gallons daily consumption, more or less, in Pittsburgh is water settled in the sedimentation basins. The two waters are mixed, since there is no way of keeping them separated.

"If the thirty-nine filters were operated at their normal capacity, all of the seventy million gallons would be filtered. This result is to be accomplished as soon as possible. Fifteen men are now engaged in operating galleries; they are distributed as follows: two filter attendants for four galleries; two laborers for four galleries; one filter foreman; this makes a force of five men for four galleries for each shift of eight hours or fifteen men for each twenty-four hours. An additional filter attendant and an additional filter laborer for each shift is to be put on. This will make twenty-seven men for each twenty-four hours instead of fifteen men. With this force the higher rates are to be attained as soon as possible without jeopardizing the entire plant.

"In the cleaning operations there are now employed four machine operators, four filter laborers, two washer attendants and one machinist. This force is to be doubled. It has been found necessary to do this to successfully work all the filters. Without adequate cleaning force, if the beds were run to their full capacity, it would tie up the entire plant. The unusually high turbidity of the Allegheny River this summer has retarded the development of the filters to their maximum efficiency.

"In the laboratory work, whose results give the important index of necessary corrective measures in daily and hourly operation there are now employed one analyst in charge, one assistant chemist, two laboratory assistants, two sample collectors and one laborer. Other help will be employed as required.

"Proposed Additions.

"The city asks approval of plans for the erection of ten additional filter units of the same size and form of construction as the existing filters, to be located upstream on the land belonging to the city and reserved for this purpose.

"The annexation of Allegheny City has extended the territory and usefulness of the filtration works. The present plant has a maximum capacity of one hundred million gallons. The greatest consumption in Pittsburgh as recorded is eighty-three million gallons. The Monongahela Water Company's district, if supplied by the city, will call for twelve million additional gallons of filtered water, making a total of ninety-five million gallons needed.

"The 'North Side' consumption is now forty thousand gallons daily; so it is evident that ten additional units are none too many. It is understood, however, that experiments with preliminary treatment are now in progress as a basis of design for materially increasing the capacity of the existing sand beds. This study of preliminary treatment is heartily recommended. The State Department of Health will be glad to favorably consider any well conceived method, thoroughly tested, with special reference to adaptability to local conditions.

"The exigencies of the case, however, warrant no delay in providing for additional capacity, and the plans proposed for ten filters should be executed at once.

"The city also proposes, as soon as money therefor shall have been provided, to add low service pumping machinery to the Ross pumping station and to build and equip a new high service pumping station at Aspinwall for the purpose of delivering filtered water into the Allegheny mains; and when this has been done, to abandon the old River Avenue pumping station and also the Montrose pumping station.

"Further, it is contemplated to build a reservoir of about one hundred million gallons capacity somewhere along the pipe line route to Allegheny.

"Still further, in connection with the furnishing of filtered water to the 'South Side' when the city takes over the works of the Monongahela Water Company, it purposes to abandon the use of the low service pumps at the 29th Street Station at once and to deliver filtered water into the district mains. The filtered water supply will be lifted by the high service pumps at this station to the Allentown tanks, pending the building and equipment of new high service pumps and their installation in a new house to be erected at a site free from inundations or floods. Upon completion of this work the 29th Street station will be entirely abandoned."

(b)—The Commissioner of Health's Decree of 1908 and its Fulfillment.

This description was followed by a discussion of the Pittsburgh water supply situation and the decree, as follows:—

"The policy of the State in subserving the interests of public health bears a peculiar relationship to the endeavors of the authorities of Pittsburgh along the same lines. The sewages of the municipalities situated on the banks of the Allegheny and Monongahela Rivers above Pittsburgh pollute to a very considerable degree the waters which are the source of supply to all the districts hereinbefore described. Even the city's own sewage pollutes the water which passes over or by the intakes of the River Avenue, 29th Street and Esplan pumping stations. To these facts have been attributed rightfully a considerable proportion of the typhoid fever cases and deaths of Allegheny County.

"A circuit between the city, its environment and the country beyond is existent no doubt whereby infection is transmitted back and forth through the medium of water, milk and food stuffs. The circuit can only be cut when all of the drinking water in the city is pure.

"A compulsory proper disposal of household wastes of a poisonous nature at the farms and in the villages is going along apace under State direction; but the compulsory discontinuance of the discharge of municipal sewage into the city's drinking water must necessarily require a long term of years for accomplishment. Meantime, the people must have pure water, and there is one law for all water works whether owned and operated by a private or municipal corporation. The Pennsylvania Water Company now has pending before the State Department for approval, plans for improving its water supply which have a relation to the future development of the municipal system. The Monongahela Water Company, held up for the time being in making improvements by the probability of having its plant partly taken away, must also provide adequate works to purify the water supplied to its consumers and a decree to this effect will be issued.

"It has been determined that the existing city water works will not be prejudicial to public health under certain conditions, and the same are hereby and herein approved and a permit granted for the proposed extensions, alterations and improvements, under the following conditions and stipulations:

"*FIRST:* That this permit shall relate only to the water works now owned and operated or that may be owned and operated by the city between the territory now comprised within the boundaries of the city of Pittsburgh as incorporated August 1st, 1908. The acquirement of water works or extensions of water works by the city into any area beyond the said municipal territory of August 1st, 1908, shall be made under the provisions of law requiring a written permit by the Commissioner of Health.

"*SECOND:* That the city shall immediately upon its acquirement of the Monongahela Water Company's plant in the thirteen wards, fully inform the Commissioner of Health of the fact of the nature and terms of the agreement between the city and the water company and the extent of the plant as acquired, more particularly in its bearing to any remaining property or works of the said water company within the city limits and similar information shall be given with regards to any acquirement of the Pennsylvania Water Company's plant in part by the city.

"*THIRD:* That monthly reports of the operation of the water purification plant and of the water works system, shall be filed in the office of the Commissioner of Health on forms satisfactory to said Commissioner. At the close of each season's

work, the city shall file satisfactory plans showing all additions, extensions and changes in the water works system made during the year, together with any other information in connection therewith, that may be required.

"FOURTH: That the city shall not later than December 1st, 1911, supply the 'North Side' and the 'South Side' and the old city proper, with filtered water and filtered water only. Provided, however, that if the Monongahela Water Company should not be acquired by the city then, in that event, the State Board of Health will require the said water company to filter the water supplied to all its consumers. And on or before December 1st, 1911, the abandonment of the Montrose and River Avenue pumping stations shall have been accomplished and also the 29th Street Station, if this latter property shall have been acquired by the city in time to admit of the changes in plans herein approved relative thereto being made, otherwise a reasonable extension of time will be granted by the Commissioner of Health. It is the intent of this permit to bring about at the earliest practicable moment the elimination from the water works system of all emergency and other intakes, whereby raw river water may be introduced into the distributing system.

"FIFTH: That since greater filter capacity than that now possessed at the Aspinwall plant together with the ten additional filter units is requisite to the furnishing of the entire city with filtered water, it is stipulated that tests of the preliminary treatment of the Allegheny River water shall be conducted by the city preparatory to the adoption of the best treatment, and that prior to the installation of any permanent method, the plans therefor, together with the tests showing the adaptability of the process, shall be submitted to the Commissioner of Health for approval.

"SIXTH: If at any time it shall appear that the water works system or any part thereof, or the water supplied to the public thereby is prejudicial to public health, then such remedial measures shall be adopted forthwith as the Commissioner of Health may approve or advise."

On March 29th, 1912, the city of Pittsburgh submitted to the State Department of Health for consideration and approval, reports showing results of tests conducted by the city in carrying out the 1908 decree of the Commission of Health, to determine the most efficient preliminary treatment of the water prior to filtration in order to economically increase the output of the slow sand filter plant and supply the entire city with filtered water of a satisfactory quality. At that time, March, 1912, the city had purchased the Monongahela Water Company plant. February 1st, 1909, filtered water was first supplied to the "South Side" and since then this service has been continued; but a part of the inhabitants of the Twentieth ward are still furnished as formerly with Ohio River water drawn from the cribs and wells at the Esplen station of the Monongahela Water Company and Wards 38, 42, 43 and 44 are supplied as formerly by the South Pittsburgh Water Company.

The city shut down the River Avenue station in Allegheny during February, 1908, and since then all of the water to the "North Side" has been pumped from the Allegheny River at the Montrose station. On and after October 1st, 1908, all of the water supplied to the Peninsula district of Pittsburgh, has been filtered water. Prior to October 1st, 1908, and beginning December, 1907, mixed raw and filtered water was supplied to the Peninsula.

Briefly described, the water works system, March, 1912, comprised a filter plant at Aspinwall and the Ross pumping station there which raises the raw river water from the Allegheny to the filtration plant; the gravity conduits under the river that feed the filtered water to the Brilliant pumping station; the Brilliant pumping station by

means of which all filtered water is delivered to the filtered water district consisting of the Peninsula of Pittsburgh and the "South Side," excluding those parts on the "South Side" furnished by the Monongahela Water Company and the South Pittsburgh Water Company as already mentioned; the Highland storage reservoirs, total storage capacity, 238,000,000 gallons, into which all filtered water is primarily raised and from which it is delivered to the water district sub-divided into low, high and extra high service—the low service district being supplied from Highland Reservoir No. 2, the high service being supplied from Highland Reservoir No. 1, and the extra high service district being furnished with water pumped from the high service mains into reservoirs and tanks located at such points and elevations as to serve districts above the reach of the high service district; the unfiltered water district consisting of the Twentieth Ward on the "South Side," supplied from the Esplen station of the Monongahela Water Company; and the unfiltered water district on the "North Side"—Wards 21 to 27 inclusive—supplied from the Montrose station in O'Hara Township opposite Verona, nine miles and a half up stream from the mouth of the Allegheny River. The Montrose intake has a timber crib which does not prevent turbid water from reaching the pumps and being supplied to the consumers in the "North Side." Since November 30th, 1911, chlorinated lime has been applied to all of the water pumped at this station. The water is delivered by the pumps into the low service district of the "North Side," the surplus overflowing into the Troy Hill reservoir (7.5 million gallons capacity). From this reservoir water is either pumped directly or fed by gravity to the high district pumping station and there are also extra high service districts supplied by their own auxiliary pumping stations and tanks; but the water all comes primarily through the Montrose pumping station. One of the projected improvements is a large storage reservoir on the "North Side" to be constructed on a level with the Highland reservoir. Another improvement is the erection of a filtered water pumping station for the "North Side." The plans are well along and when this station and reservoir are constructed, the Montrose station will be abandoned.

It is thus seen that the city has made progress in fulfilling the conditions of the 1908 decree; but there are further changes, extensions and improvements to be made in the works to supply water to the Pittsburgh district. The city is expanding and the plans must anticipate the future growth.

According to the census of 1910, the population of Pittsburgh was 533,900. The daily water consumption is 132,000,000 gallons equivalent to a per capita rate of 247 gallons. In the following table is given the average daily pumpage, by months, of filtered water at the Brilliant station.

TABLE LXXIV.

Average Daily Pumpage by Months of Filtered Water at Brilliant Pumping Station.
(In Million Gallons.)

Month.	1909.	1910.	1911.	1912.
January,	69	93	92	97
February,	73	94	89	102
March,	80	87	87	91
April,	78	89	83	87
May,	82	87	88	87
June,	84	90	90	90
July,	87	96	97	95
August,	81	96	94	93
September,	84	94	90	96
October,	81	92	88	91
November,	82	88	86	87
December,	83	94	82	88
Averages,	80	92	89	92

The average daily consumption on the "North Side" is 35,000,000 gallons and in the Twentieth Ward approximately 5,000,000 gallons. In the following table is given the average daily consumption of filtered water and unfiltered water, the population of the respective districts and the per capita consumption.

TABLE LXXV.

The Population of Pittsburgh by Filtered and Unfiltered Water Districts, and the Daily and Per Capita Consumption in said Districts.

Water District.	Population.	Average Daily Consumption in gallons.	Average per capita Consumption in gallons.
Filtered,	331,000	92,000,000	235
Unfiltered:			
North side,	133,000	35,000,000	263
20th ward,	10,000	5,000,000	500
	143,000	40,000,000	280
Totals,	534,000	132,000,000	247

The largest single day's consumption of filtered water has been 113,000,000 gallons up to March, 1912, and of unfiltered water about 45,000,000 gallons, or in round numbers 158,000,000 gallons consumption, equivalent to about 20 per cent. in excess of the average daily consumption.

In estimating what the future demands may be, all kinds of calculations might be made with some show of reason. It is conservative to assume that the population within the present city limits will increase fifteen per cent. by decades until about a million people reside within these limits, and that within this time the population in the suburbs will increase twenty per cent. by decades. In the ten mile zone next beyond the city boundaries, in the year 1910, there was a population of 509,000 persons. Along the Allegheny River below Aspinwall and then along the Ohio River there are eighteen boroughs and six townships within the metropolitan district, as defined by the Federal Census Bureau, which might at no great future date be furnished with water from the Aspinwall plant. These places are as follows: Aspinwall, Sharpsburg, Etna, Millvale, Spring Garden, West View, Bellevue, Avalon, Emsworth, Ben Avon, Glenfield, Osborne, Haysville, Sewickley, Edgeworth, Leetsdale, Coraopolis, McKees Rocks, making eighteen boroughs with a population of 70,260; and Shaler, Reserve, Kilbuck, Aleppo, Neville, and Stowe Townships, making six townships with a population of 14,180; or a total for this district of 84,440 people.

In the lower valley of Chartiers Creek, along the south side of Pittsburgh territory, and the banks of the Monongahela, there is a chain of boroughs and townships, largely supplied by the South Pittsburgh Water Company, that may in the future be furnished with Allegheny River Water from Aspinwall. These places are as follows: Ingram, Crafton, Greentree, Thornburg, Carnegie, Heidelberg, Dormont, Carrick, St. Clair, Mt. Oliver, Knoxville, Hays, Homestead, and West Homestead, Munhall, and Whitaker, making sixteen boroughs with a population of 72,830; and Chartiers, Scott, Union, and Baldwin townships, making four townships with a population of 20,600; or a total population for this district of 93,430 people.

East of Pittsburgh and along the lower Turtle Creek valley, there is a chain of municipalities furnished with water by the Pennsylvania Water Company. These places are in the metropolitan district. They are as follows: Pitscairn, Trafford City, Wall, East McKeesport, Wilmerding, Turtle Creek, East Pittsburgh, North Braddock, Braddock, Rankin, Swissvale, Edgewood and Wilkinsburg, making thirteen boroughs with a population of 93,500 people; and Braddock, Wilkins, Penn. Patton, and North Versailles townships, making five townships, with a population of 9,540 people; or a total population for this district of 103,040 people.

Around McKeesport there is a district that may some time be supplied with water from the Aspinwall plant. The towns are as follows: the city of McKeesport, population 43,000; the boroughs of Duquesne, Versailles, Port Vue, Glassport, Dravosburg, Clairton,

Wilson, Elizabeth, West Elizabeth, making nine boroughs with a population of 34,240; and the township of South Versailles, population 420; a total population in the district of 77,660 persons.

TABLE LXXVI.

Summary of Population in Suburbs Outside of Pittsburgh.

Suburban Districts.	Boroughs.		Townships.	
	Number of.	Population.	Number of.	Population.
River District,	18	70,260	6	14,180
S. Pittsburgh Dist.,	16	72,830	4	29,606
E. Pittsburgh Dist.,	13	23,560	6	9,540
McKeesport Dist.,	10	77,240	1	420
Totals,	57	313,830	17	44,746

So we see that in the suburbs around Pittsburgh there are fifty-seven boroughs, including the city of McKeesport as a borough, having a total population of 313,830, and seventeen townships having a total population of 44,740. In other words, there are seventy-four distinct civil government districts in these suburbs having an aggregate population of 358,570 people. In Table LXXVII is given this aggregate population by main sub-districts and the public water consumption in each in gallons daily.

TABLE LXXVII.

Suburban Populations and Daily Water Consumption.

Suburban Districts.	Total population.	Water consumption, gal- lons daily.
River District,	84,440	8,400,000
S. Pittsburgh Dist.,	83,436	9,500,000
E. Pittsburgh Dist.,	103,040	13,800,000
McKeesport Dist.,	77,660	6,300,000
Totals,	358,570	38,000,000

As stated before, within ten miles of the city boundaries, in 1910, there was a population of 509,000 people. It is more conservative for our present purpose in discussing a metropolitan water works system of the future, to take the 359,000 basis of population residing

in the outlying districts, as shown in Table LXXVII, than the 509,000 basis. According to the Federal census, in the metropolitan district of Pittsburgh, which is taken to extend beyond Allegheny County, there is a population of 1,042,000 people. Even on the basis of a population of 359,000 in the outside water districts enumerated, and figuring on the basis of growth of fifteen per cent. for the central city and twenty per cent. for these outside districts, the figures will run high. The following table gives the increase in population by decades on this conservative basis of growth, and it is illustrated in Diagram C.

TABLE LXXVIII.

Future Population Estimated for Pittsburgh and Seventy-four Adjacent Civil Districts Comprising What is Considered to be a Probable Future Metropolitan Water District.

Period in Decades.	Population in Metropolitan Water District.		
	Present Pittsburgh incorporated area.	Seventy-four adjacent civil territories.	Total Metropolitan water district.
1910,	534,000	359,000	893,000
1920,	614,000	431,000	1,045,000
1930,	706,000	517,000	1,223,000
1940,	812,000	620,000	1,432,000
1950,	934,000	744,000	1,678,000

If the Federal Metropolitan District were taken to be the future water district, then the growth in population might be as follows:

	Present city limits.	Outside territory.	Total.
1910,	534,000	509,000	1,043,000
1920,	614,000	611,000	1,225,000
1930,	706,000	733,000	1,439,000
1940,	812,000	880,000	1,692,000
1950,	934,000	1,056,000	1,990,000

The population of 359,000 persons living in the seventy-four civil districts adjacent to Pittsburgh now uses 38,000,000 gallons of public water daily, which is about 100 gallons per capita; but as this population increases the consumption rate will increase.

DIAGRAM C

ESTIMATED POPULATION IN THE METROPOLITAN DISTRICT OF PITTSBURGH FOR 40 YEARS BASED ON A CONSERVATIVE GROWTH OF 15 PERCENT INCREASE IN URBAN AND 20 PERCENT INCREASE IN SUBURBAN DISTRICTS EACH DECADE

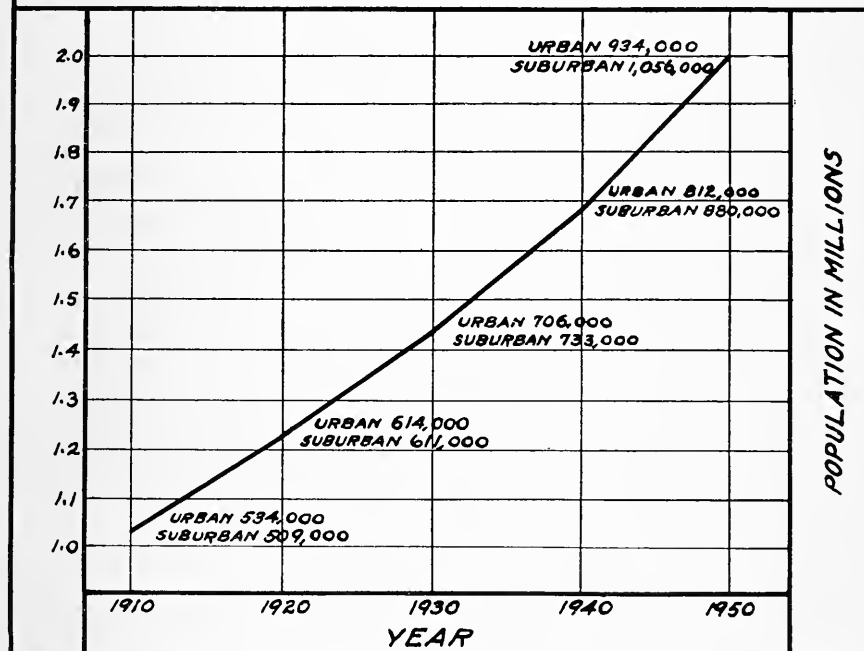
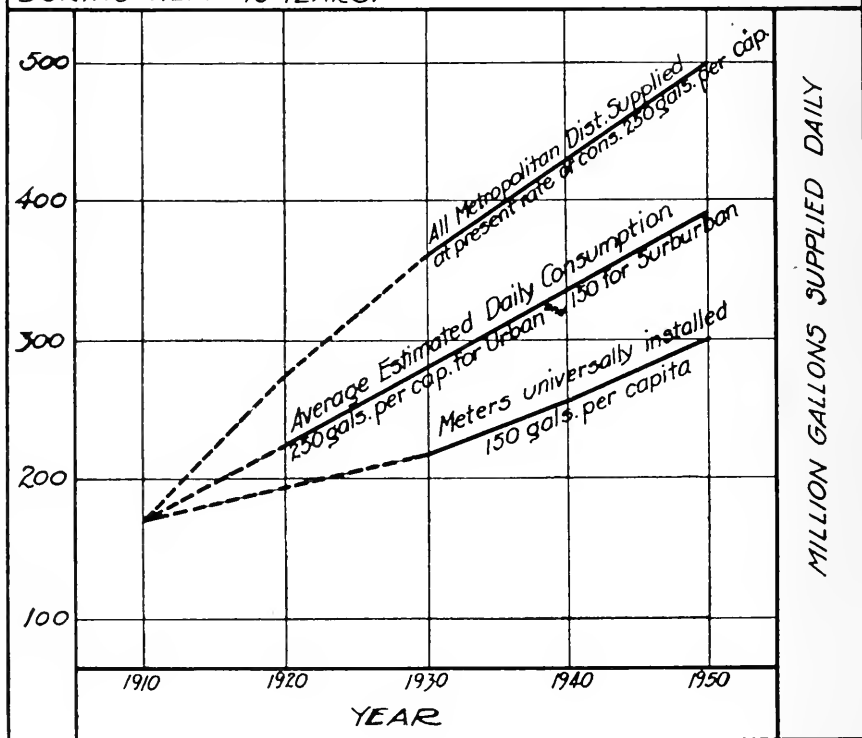


DIAGRAM D

ESTIMATED DAILY CONSUMPTION OF WATER IN MILLION GALLONS FOR ENTIRE METROPOLITAN DISTRICT OF PITTSBURG. FOR DIFFERENT CONDITIONS THAT MAY OBTAIN DURING NEXT 40 YEARS.



At present in Pittsburgh the per capita consumption is 250 gallons in round numbers. If meters were universally installed, this rate would be reduced, let us say, to 150 gallons per capita daily. Table LXXIX shows the estimated daily consumption in million gallons for the future. In the first column are the periods by decades. In the second column are the estimated daily consumptions for the present city limits, on the basis that the per capita rate will continue to be 250 gallons daily. In the third column the daily consumptions are given for the metropolitan area outside of the city, on the basis that in 1920 and thereafter all of the people there will be supplied with public water at a rate of 150 gallons per capita. The fourth column gives the total daily consumption of the entire water district, comprising the present city limits and the outlying territory, and hence it is the sum of the items in the other two columns for the respective decades. This column of totals is taken to represent the mean consumption for the future water district, that is, it is not the maximum that can happen, neither is it the minimum. The fifth column gives the estimated minimum total consumption for the future water district. The figures are based on the assumption that meters will be universally installed and that the daily per capita consumption by 1930 and thereafter for the entire metropolitan district will be 150 gallons. And the last column gives the maximum consumption. It is based on the assumption that meters will not be installed, and that, in consequence, the great waste of water now going on will continue and that by 1930 and thereafter all of the people in the metropolitan district will be using water at the daily per capita rate of 250 gallons. Diagram D graphically illustrates the table.

TABLE LXXIX.

Estimated Daily Water Consumption in Million Gallons for a Future Water District Comprising Part of the Federal Pittsburgh Metropolitan Territory and for One Comprising All of said Metropolitan Territory.

Period in Decades.	city present Within limits.	Out- Metropolitan area. lying districts.	Total Consumption Under Stated Conditions.		
			On Basis of pres- ent consumption. Mean.	If meters were in- stalled. Mini- mum.	Possible consump- tion without meters. Maxi- mum.
Part 1 Metropolitan Area.					
1910,	134	38	172	.....	.....
1920,	154	65	219	.....	.....
1930,	167	78	245	134	306
1940,	203	93	296	215	358
1950,	234	113	346	252	420
Entire Federal Metropolitan Area.					
1910,	134	38	172	.....	.....
1920,	154	92	246	.....	.....
1930,	167	110	277	216	360
1940,	203	132	335	254	423
1950,	234	153	392	294	498

Based on these estimates, if meters were introduced and the partial metropolitan district were supplied by the city, in 1930 the daily consumption would be 184,000,000 gallons and by 1950 the daily consumption would be 252,000,000 gallons; while if the city neglects universally to install meters the consumption may be between 346,000,000 gallons and 420,000,000 gallons by the year 1950. If the city supplies the entire Federal metropolitan district, by 1930, the mean daily consumption may be 277,000,000 gallons, the minimum 216,000,000 gallons and the maximum 360,000,000 gallons, and by 1950 the mean daily consumption may be 392,000,000 gallons, the minimum 298,000,000 gallons and the maximum 498,000,000 gallons. It is not beyond the range of probability that the city of Pittsburgh may be supplying the public with 350,000,000 gallons of water forty years hence.

(c)—Typhoid Fever in Pittsburgh before and after Water Filtration.

In March, 1912, the ten additional filter units, approved in 1908, were built but not put in operation. During 1907, and prior to that time, raw Allegheny River water was supplied to Pittsburgh. On December 19th, of 1907, some filtered water was pumped into the Highland reservoirs. The volume of filtered water so pumped was constantly increased during the year 1908, until on October 3rd of 1908, all of the water supplied to the Peninsula districts of Pittsburgh was filtered; since, filtered water only has been furnished to this Peninsula district.

The "South Side" continued to receive raw Monongahela River water until February 4th, 1909, when filtered water was introduced there from the Highland reservoir—excluding of course the wards furnished by the South Pittsburgh Water Company that has a filtered supply of its own, and the Twentieth Ward, supplied from Esplan with raw water by the Monongahela Water Company. We will first take up the existence of typhoid in the Peninsula district and then in the "South Side."

In Table LXXX is given the record of typhoid fever cases in Peninsula Pittsburgh by years since 1896. It includes that portion of the city which is supplied by the Pennsylvania Water Company. The population in the company's district was 24,000 in 1910, an increase of 19,000 in ten years. The population in the remaining portion of the Peninsula District was 270,000 in 1910, an increase of 33,000 in ten years; so that in the entire Peninsula District in 1910, the population was 294,000.

TABLE LXXX.

City Record of Typhoid Fever Cases in Peninsula Pittsburgh, 1896—1912, inclusive.

Year.	City waters works district.	Pennsylvania Water Co. Water Works district.	Total for Peninsula.
1896,	945	16	961
1897,	998	2	910
1898,	1,406	15	1,421
1899,	1,352	5	1,361
1900,	2,374	50	2,424
1901,	2,433	36	2,469
1902,	2,463	39	2,502
1903,	2,623	73	2,696
1904,	2,527	82	2,609
1905,	2,375	140	2,515
1906,	4,646	286	4,932
1907,	3,962	54	4,016
1908,	1,059	24	1,083
1909,	292	34	326
1910,	274	21	295
1911,	187	7	194
1912,	128	15	143

It will be noted that in the Pennsylvania Water Company district of the Peninsula, the number of typhoid cases was relatively smaller. Up to July, 1910, as previously stated, the supply came from the Allegheny River and was drawn through a crib and to the fact that considerable purification was effected at the cribs the smaller number of typhoid cases has been attributed. The increase in typhoid cases noted in the table during 1905-1906, was thought to be due to an accident to the cribs which materially reduced their efficiency. Since July, 1910, the company has operated a mechanical filter plant and this accounts for the lower rates in 1911-12.

In Table LXXXI are given the typhoid fever cases by months in the Peninsula district excluding the Thirteenth Ward and it is offered to show how the typhoid dropped off as the efficiency of the Aspinwall filter plant increased. Three filters were put into commission at Aspinwall during December of 1907, and during January, 1908, seven additional filter units were put into commission, eight others in March, six in April and three in May; and during July, 1908, thirty-nine filter units were operated and on October 3rd, 1908, all of the water supplied to the peninsula was filtered and has since been filtered. In the following table it will be shown that, beginning with the first of the year, 1908, when a small volume of filtered water mingled with a large volume of unfiltered water that was furnished to the consumers of the city district of the Peninsula, the proportion of filtered water to the raw water increased as the months went by and correspondingly typhoid fever cases fell off.

TABLE LXXXI.

Typhoid Fever Cases in Peninsula Pittsburgh by Months 1907-1912, inclusive.
(Excluding the Thirteenth Ward, the Pennsylvania Water Company Area.)

Month.	1907.	1908.	1909.	1910.	1911.	1912.
January,	537	340	26	15	18	16
February,	271	141	23	19	12	10
March,	135	71	26	21	7	11
April,	169	81	15	17	12	5
May,	292	64	26	17	12	14
June,	152	63	14	16	16	12
July,	300	62	22	23	15	15
August,	375	81	26	35	28	17
September,	228	47	36	40	23	7
October,	349	46	28	26	15	14
November,	441	27	32	23	14	4
December,	413	36	18	22	15	9
Totals,	3,962	1,059	292	274	187	128

In Table LXXXII the occurrence of typhoid fever in that part of Pittsburgh called the "South Side" is given for the years 1890 to 1912, inclusive.

In the first column appear the cases in the territory formerly supplied with raw water from the Monongahela River by the Monongahela Water Company. This includes Wards 24 and 36 inclusive. These works were purchased by the city and since February 4, 1909, filtered water has been supplied to the people in this district. It will be noted that typhoid diminished very materially in this territory during 1909 and the years which have followed since filtered water has been furnished. The population in this section of South Pittsburgh in 1910, was 80,000, being an increase of 14,000 in ten years.

In the second column appear the cases in the Thirty-ninth and Fortieth Wards (old classification), the territory supplied with water from wells and the Ohio River at the Esplen works of the Monongahela Water Company. The population in this section of South Pittsburgh in 1910, was 9,000, being an increase of about 3,000 in ten years.

In the third column appear the cases in Wards 38, 42, 43 and 44 (formerly Beltzhoover, Montooth, Sheradan, and West Liberty boroughs) supplied with filtered water by the South Pittsburgh Water Company since July 14, 1906. Prior to that the source was raw river water drawn from the Monongahela at Beck's Run. It will be noted that typhoid has not dropped off much since the filtering of this supply as shown by the table. The population in this section of South Pittsburgh in 1910, was 17,000, being an increase of about 8,600 in ten years.

In the last column are given the total cases by years for the entire South Side of Pittsburgh and the decline in typhoid for the last three years is apparent. In the "South Side" the total population in 1910 was 106,000 persons, an increase of about 26,000 in ten years.

TABLE LXXXII.

Typhoid Fever Cases in South Side District.

Year.	Wards 24 to 36 inclusive. Upper Intake district. (Mon. Water Co. prior to 1908).	Wards 39 & 40. Lower Intake. (Esplan. Dis- trict. Monongahela Water Co.)	Wards 38, 42, 43 & 44 River crabs and me- chanical filters. (South Pittsburgh Co. Dis- trict.)	Total for all South Side Pittsburgh.
1890,	281	.....	.....	251
1891,	217	.....	.....	217
1892,	248	.....	.....	248
1893,	342	.....	.....	342
1894,	183	.....	.....	183
1895,	254	.....	.....	254
1896,	255	.....	.....	255
1897,	366	.....	.....	366
1898,	356	.....	7	263
1899,	638	.....	50	688
1900,	498	.....	26	524
1901,	685	.....	31	716
1902,	426	.....	28	456
1903,	506	.....	31	537
1904,	311	.....	10	321
1905,	236	.....	18	269
1906,	412	36	19	467
1907,	361	27	24	412
1908,	268	29	31	268
1909,	78	17	32	127
1910,	54	10	34	98
1911,	43	8	25	76
1912,	53	12	11	76

In Allegheny City (annexed to Pittsburgh in 1908) typhoid fever cases were not recorded, or at least the records are not available for cases until 1908, although the deaths have been recorded for many years. The population in Allegheny City, now "North Side" of Pittsburgh, in 1910 was 132,000, being an increase of about 2,000 in ten years. In Table LXXXIII are given the deaths and approximate number of cases in Allegheny City prior to annexation, and the death rates for each 100,000 population for Allegheny City and for Pittsburgh prior to annexation, and the cases and deaths in the "North Side" after annexation.

TABLE LXXXIII.
Allegheny City Typhoid Fever, 1900—1912, inclusive.

Year.	Cases (approximate before 1908.)	Total number of deaths.	Death Rate in each 100,000.	
			Allegheny City.	Pittsburgh City.
Before Annexation.				
1900,	726	121	93.1	147.2
1901,	815	135	103.6	124.0
1902,	894	149	114.2	141.1
1903,	940	121	94.9	137.3
1904,	1,000	166	176.9	140.5
1905,	1,090	182	139.0	109.1
1906,	1,120	198	151.0	143.6
1907,	850	143	108.8	132.1
After Annexation, as "North Side."				
1908,	363	60		
1909,	297	41		
1910,	428	63		
1911,	367	62		
1912,	108	13		

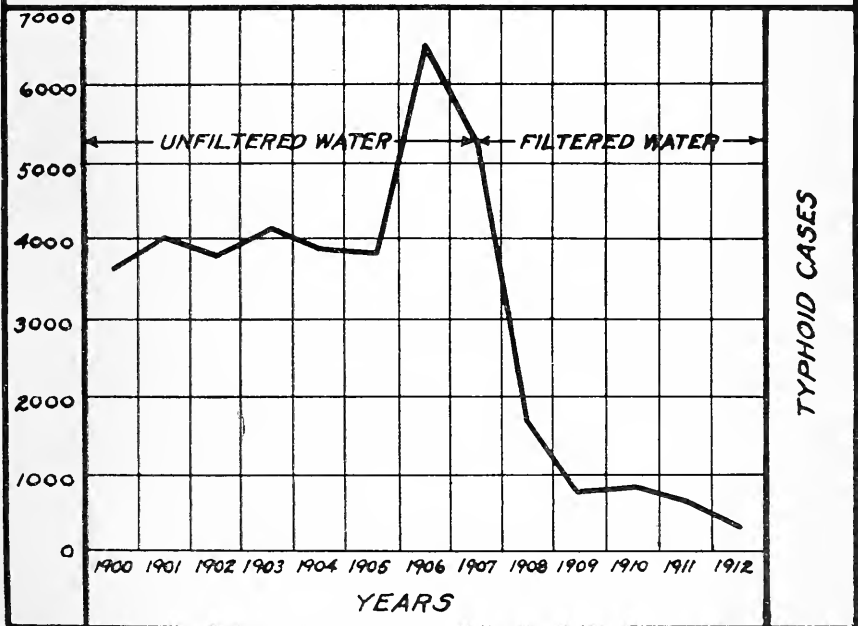
In Table LXXXIV is given a summary of typhoid fever cases in the city of Pittsburgh before and after filtration of the public water supply. In 1908 some water was filtered at Aspinwall and in 1909 all of the water was filtered with the exceptions hereinbefore noted. The table is graphically illustrated by Diagram E.

TABLE LXXXIV.
Summary of Typhoid Fever Cases in the City of Pittsburgh, 1900—1912, inclusive.

Year.	Peninsula district.	"South Side" district.	"North Side," Allegheny.	Total in city.
1900,	2,424	524	726	3,674
1901,	2,469	716	815	4,000
1902,	2,502	456	894	3,852
1903,	2,696	537	940	4,173
1904,	2,609	321	1,000	3,930
1905,	2,515	269	1,090	3,874
1906,	4,932	467	1,120	6,519
1907,	4,016	412	850	5,278
1908,	1,083	268	363	1,714
1909,	325	127	297	749
1910,	295	98	428	821
1911,	191	76	367	637
1912,	143	76	108	327

DIAGRAM E

*CHART OF TYPHOID FEVER CASES IN
PITTSBURGH-ALL OF PRESENT MUNICIPAL
TERRITORY-FOR THE PAST THIRTEEN YEARS*





The reduction in typhoid fever accompanying the introduction of filtered water throughout the city is shown graphically in the accompanying Diagram E.

In Table LXXXV are given the typhoid fever cases summarized for the filtered water district within the city of Pittsburgh limits, including the cribs as filters. In the first column the cases are shown in the Pennsylvania Water Company district; in the second column the cases for the South Pittsburgh Water Company district; in the third column the cases for the City Water District in the Peninsula after all the water was filtered; and in the fourth column the cases in the South Side in the City Water District after all the water was filtered; and in the fifth column are given the total typhoid fever cases in the entire filtered water areas for the years 1900 to 1912 inclusive; and in the last column the rate for each 100,000 of population. It will be noted that in 1900, the total population in the filtered water districts was 13,400 only, and that that year there were seventy-six cases of typhoid fever among the consumers and entire population residing in these areas which gave a rate of 567 cases to 100,000 of population. Furthermore, it will be noted that in 1910, the total population in the filtered water districts was 391,000 and that year there were only 383 cases of typhoid fever among this big population which gave a rate of ninety-eight cases to 100,000 of population. The next year the rate came down to sixty-seven cases for the filtered water districts and for the year 1912, the rate was fifty-one, estimating the population in these districts to be 403,000 persons.

TABLE LXXXV.

Summary of Typhoid Fever Cases in the Filtered Water Districts Within the Limits of Pittsburgh, 1900—1912, inclusive.

Year.	Pennsylvania Water Co. District.	South Pittsburgh Water Co. District.	Peninsula City Water District.	"South Side" City water.	Total Typhoid Cases.	Rate in 100,000 population.
1900,	50	26 crib.	.....	.....	76	567
1901,	36 crib.	31 crib.	.....	.....	67	.....
1902,	39 crib.	28 crib.	.....	.....	67	.....
1903,	73 crib.	31 crib.	.....	.....	104	.....
1904,	32 crib.	10 crib.	.....	.....	92	.....
1905,	140 crib.	18 crib.	.....	.....	158	.....
1906,	286 crib.	19 filter.	.....	.....	305	.....
1907,	54 crib.	24 filter.	.....	.....	78	.....
1908,	24 crib.	31 filter.	.....	.....	55	.....
1909,	34 crib.	30 filter.	292 filter.	78 filter.	436	111
1910,	21 filter.	34 filter.	274 filter.	54 filter.	383	98
1911,	7 filter.	25 filter.	187 filter.	43 filter.	262	67
1912,	15 filter.	11 filter.	128 filter.	53 filter.	207	51
<hr/>						
Populations.						
1900,	5,000	8,400	237,000	66,000	316,400	.....
1910,	24,000	17,000	270,000	80,000	391,000	.....

In Table LXXXVI there is given a summary of typhoid fever cases in the raw water districts within the limits of Pittsburgh. In the first column the cases are given for the city water district in the Peninsula from 1900 to 1908 inclusive. After that this district was furnished with filtered water. In the second column the cases are given for that portion of the south side supplied by the Monongahela Water Company from the upper intake, for the years 1900 to 1908 inclusive. Then the city bought the works and thereafter filtered water was supplied to this district. In the third column the typhoid fever cases are given for the Esplen District on the South Side; in the fourth column the typhoid cases as near as they can be obtained for the "North Side" are given; and in the fifth column the total typhoid fever cases occurring in the raw water districts are given for the years 1900 to 1912 inclusive; and in the last column the rate for 100,000 population. It will be noted that in 1900 the total population in the raw water districts was 439,000, and that that year there were 3,598 cases of typhoid fever in these districts which gave a rate of 819 cases in 100,000. Furthermore, it will be noted that in 1910 the population receiving raw river water was 141,000. Probably 143,000 is nearer the actual number of persons receiving raw water then, and on this basis, and that of 438 cases among such persons there was a rate of 306 cases in 100,000 population. The next year the rate came down to 262 cases for the raw water districts and for the year 1912, the rate was 85 cases.

TABLE LXXXVI.

Summary of Typhoid Fever Cases in the Raw Water Districts Within the Limits of Pittsburgh, 1900—1912, inclusive.

Year.	Peninsula City Water District.	South Side, Monongahela Water Co.		Allegheny. "North Side" District.	Total Typhoid Cases.	Rate per 100,000 Population.
		Upper Intake District.	Esplen District.			
1900,	2,374	498	.....	722	3,598	819
1901,	2,423	685	.....	815	3,933	.....
1902,	2,463	426	.....	894	3,783	.....
1903,	2,623	506	.....	940	4,069	.....
1904,	2,527	311	.....	1,000	3,838	.....
1905,	2,375	236	15	1,000	3,716	.....
1906,	4,646	412	36	1,120	6,214	.....
1907,	3,962	361	27	850	5,200	.....
1908,	1,059	208	29	363	1,659	.....
1909,	Filter, ..	Filter, ..	17	297	314	.....
1910,	Filter, ..	Filter, ..	10	428	438	306
1911,	Filter, ..	Filter, ..	8	367	375	262
1912,	Filter, ..	Filter, ..	12	108	120	85
Approximate Populations.						
1900,		227,000	66,000	6,000	130,000	439,000
1910,		270,000	80,000	9,000	132,000	491,000

TABLE LXXXVII.

Showing Pittsburgh's Rank Among Cities of the United States in Typhoid Fever Death Rate per 100,000 Population for the Year 1911.

(By Pittsburgh Water Bureau.)

City.	Population.	Typhoid deaths.	Rate per 100,000 population.
Atlanta,	160,000	90	56.3
Pittsburgh,†	135,000	66	48.9
Baltimore,	564,545	154	27.3
New Orleans,	373,000	106	28.7
Buffalo,	435,315	103	24.8
Indianapolis,	240,060	63	24.3
Louisville,	241,254	58	24.1
Toledo,	172,899	39	22.5
Washington,	354,000	74	20.9
Milwaukee,	385,500	77	20.0
Denver,	213,281	39	18.3
Richmond,	129,291	23	17.8
Detroit,	465,766	79	17.0
San Francisco,	416,912	67	16.1
St. Louis,	637,029	109	15.9
Albany,	106,859	16	15.8
Cleveland,	580,000	85	14.7
Philadelphia,	1,580,000	223	14.1
Los Angeles,	310,198	43	13.9
Minneapolis,	302,362	36	11.9
Cincinnati,	378,728	43	11.4
Columbus,	188,357	21	11.1
New York,	4,983,385	545	10.9
Chicago,	2,244,835	243	10.8
Pittsburgh,*	410,000	41	10.0
St. Paul,	230,000	22	9.6
Boston,	688,500	63	9.2

*Filtered Water District. †Raw Water District.

In the preceding table showing typhoid death rates for the big cities in the United States as prepared by the Water Bureau, Pittsburgh filtered water territory is taken at a population of 410,000 among whom there were forty-one deaths in the year 1911, giving a death rate of ten for 100,000 population, the third lowest rate of any city shown in the table; while the raw water district of Pittsburgh is taken at a population of 135,000 among whom there were sixty-six typhoid deaths for the year 1911, giving a rate of 48.9, or next to the highest typhoid death rate shown in the table. In the following Table LXXXVII, dealing with typhoid fever deaths in the city of Pittsburgh including the city of Allegheny before it was annexed to Pittsburgh, it will appear that in the year 1911 the city of Pittsburgh contained 542,000 persons, among whom there were 107 deaths from typhoid fever, giving a death rate of 19.7 for 100,000 population, which would place Pittsburgh seventeenth in line from the city having the lowest typhoid death rate for the year 1911.

In Table LXXXVIII the first column shows the typhoid fever deaths from the year 1900 to 1907 inclusive. Allegheny City and Pittsburgh City were made one municipality in 1907 and beginning 1908, the typhoid fever deaths were all reported as Pittsburgh deaths. The Allegheny City deaths for the years 1906 and 1907 were obtained from the Bureau of Vital Statistics of the State Department of Health. Prior to that time they are Allegheny City records. Column two gives the typhoid fever deaths for the city of Pittsburgh up to and including 1905 as reported by the Federal authorities. But after that they are taken from the records of the Bureau of Vital Statistics of the State Department of Health, and this holds true for the third column. The fourth column of total population is made up as follows: In 1900, Allegheny City had a population of 130,000 and Pittsburgh 322,000, hence the total was 452,000. The 1910 census showed those wards of Pittsburgh comprising Allegheny City territory prior to annexation to have a population of 132,000 and the rest of Pittsburgh 402,000, making a total of 534,000 persons for Pittsburgh that year. It is assumed that this increase of 2,000 persons in ten years for the Allegheny City territory was equally distributed—200 increase each year—and it is further assumed that for 1911, the population was 132,500 and for 1912, 133,000. It is assumed that the 80,000 increase in population in the remaining portion of Pittsburgh excluding Allegheny City territory was distributed as follows: by the annexation of Elliott borough in 1905, 3,000; by the annexation of Esplen borough and Sterrett Township in 1906, 3,000; by the annexation of Montooth and Sheraden boroughs in 1907, 3,000; and by the annexation of West Liberty borough in 1908, 1,000, making 10,000 increased population by these annexations, and leaving 70,000 to be distributed over the other territory at the rate of 7,000 per annum. Therefore, the column of total population is the sum of these additions of these respective estimates for each year in the decade and this rate of increase is applied to the years 1911 and 1912.

TABLE LXXXVIII.

Typhoid Fever Deaths in the City of Pittsburgh Including the City of Allegheny Before It was Annexed to Pittsburgh, 1900—1912, inclusive.

Year.	Allegheny City District.	Pittsburgh City, Incorporated.	Total Typhoid Deaths.	Total Population.	Rate per 100,000 Population.
1900,	121	474	595	452,000	131.6
1901,	135	408	543	469,000	118.4
1902,	149	474	623	466,000	133.7
1903,	124	471	595	474,000	125.5
1904,	166	492	658	481,000	136.8
1905,	182	393	575	491,000	117.1
1906,	198	530	728	500,000	145.6
1907,	143	502	645	511,000	126.2
1908,	Annexed,	Consolidated,	255	520,000	49.0
1909, .....	.....	.....	130	527,000	24.6
1910, .....	.....	.....	116	534,000	21.7
1911, .....	.....	.....	107	542,000	19.7
1912, .....	.....	.....	72	549,000	13.1

Typhoid fever cases in the city of Pittsburgh territory have been reduced 85.4 per cent. on the following basis—There were for the four years prior to putting the Aspinwall filter plant in full operation (1905 to 1908 inclusive), 17,385 cases, and there were for the four succeeding years (1909 to 1912 inclusive), 2,537 cases which gives a reduction of 85.4 per cent. in typhoid cases.

Typhoid fever deaths in the city of Pittsburgh territory have been reduced 80.7 per cent. on the following basis—There were for the four years prior to putting the Aspinwall filter plant in full operation (1905 to 1908 inclusive), 2,206 typhoid deaths, and there were for the four succeeding years (1909 to 1912 inclusive) 425 deaths, which gives a reduction of 80.7 per cent. in typhoid deaths.

It is worthy of note that typhoid fever cases dropped off in the "North Side" when the disease began to decline in Pittsburgh. Over half of the citizens of Allegheny or the "North Side" are employed in Pittsburgh. Some of this decline in Allegheny was undoubted due to the closing down of the River Avenue pumping station at the beginning of 1908, and the substitution of a less polluted Allegheny River water drawn from the river at Montrose. There has been a second decline in typhoid cases on the "North Side." It dates from the beginning of the treatment of the Montrose Station water with a germicide. The chlorinated lime treatment was begun November 20th, 1911. In the following table are given the cases for the last four months prior to this treatment and for the months following this treatment to the end of the year 1912. There were 129 cases during the four months prior to treatment and but 67 cases for the four month period following the treatment.

TABLE LXXXIX.

Typhoid Fever Cases in Allegheny (North Side) Before and After Germicidal Treatment of the Raw Allegheny River Water Supplied to the District from Montrose Pumping Station

Month.	No Treatment.	Germicidal Treatment.
1911.		
August,	21	.....
September,	26	.....
October,	29	.....
November,	53	.....
December, .....	.....	42
1912.		
January, .....	.....	16
February, .....	.....	4
March, .....	.....	5
April, .....	.....	4
May, .....	.....	10
June, .....	.....	8
July, .....	.....	6
August, .....	.....	12
September, .....	.....	7
October, .....	.....	21
November, .....	.....	7
December, .....	.....	7

The raw water supplied to the Esplen District (population 9,000) contains sewage organisms all the time. It is remarkable that there were only eight cases of typhoid fever in this district during 1911 and twelve cases for the year 1912. The results of bacteriological examinations of water drawn from taps in this district are given in the following table for the period of one year. The tests were made at the Aspinwall laboratory.

TABLE XC.

Bacteriological Analyses of Water Drawn from Taps in the Esplen District.

Date.	Average Bacteria per Cubic Centimeter.	
	Total.	B. Coll.
1911.		
March,	32,731	3.9
April,	25,467	11.0
May,	12,346	1.2
June,	14,196	8.9
July,	8,467	19.4
August,	13,623	64.9
September,	5,223	49.0
October,	4,864	31.0
November,	18,562	10.2
December,	10,850	15.2
1912.		
January,	28,373	21.0
February,	6,113	12.4

(d)—*Quality of Allegheny River Water at Ross Pumping Station.*

Daily bacteriological examinations are made by the city Water Bureau of the raw river water, the settled water, and the filtered water at the Aspinwall plant. Sewage organisms are always present in the unfiltered waters except when the river is acid. Sometimes for over twelve days the raw water will contain over 100 B. Coli to the cubic centimeter. In Table XCI are given averages of these daily examinations of the raw and settled waters by months for the years 1910 to 1912.

TABLE XCI.

Average Daily Bacterial Analyses of the Allegheny River Water—Raw and Settled—at the Aspinwall Filter Plant for each Month, by the City Laboratory.

Month.	1910.		1911.		1912.	
	Total.	B. Coli.	Total.	B. Coli.	Total.	B. Coli.
In One c. c. Raw River Water.						
January,	14,472	25	16,774	31	38,897	28
February,	8,245	22	10,393	11	9,707	27
March,	7,185	30	21,148	22	26,089	23
April,	205,233	40	22,638	23	11,107	30
May,	204,867	28	71,203	19	16,219	53
June,	47,190	30	61,117	36	62,237	42
July,	16,631	41	8,750	28	21,103	54
August,	11,806	52	18,940	21	24,256	45
September,	14,405	53	16,847	70	28,583	43
October,	67,333	29	13,517	56	52,813	43
November,	26,990	48	15,655	46	12,317	24
December,	33,694	45	8,852	48	14,460	31
In One c. c. Settled River Water.						
January,	21,125	18	14,168	21	17,554	21
February,	8,550	13	16,975	8	12,413	31
March,	8,574	18	94,222	6	15,588	23
April,	103,673	35	51,146	19	9,404	26
May,	169,200	21	92,042	24	16,827	40
June,	32,673	26	29,646	31	46,576	41
July,	6,978	34	6,519	23	15,265	55
August,	9,785	39	16,296	44	24,274	35
September,	10,448	37	11,412	63	21,150	42
October,	50,152	18	11,404	61	74,931	45
November,	50,196	30	40,196	24	35,842	37
December,	78,365	43	17,020	30	21,477	28

It appears from this table that there is little or no difference in the bacterial quality of the raw river water compared with the settled water. With the exception of a few days of the year when the river water carries heavy sediment, sedimentation has proven of little value to the operation of the slow sand filters.

The turbidities of the Allegheny River water are affected largely at Aspinwall by the distribution of the rainfall on the Allegheny Basin. Those of February 27th, 1912, were greater by fifty per cent. than any pervious average daily river turbidity since the Aspinwall filter plant was started. A sample collected during the forenoon of that day showed a turbidity of 3,900 parts in a million which was the highest observed at Aspinwall. In Table XCII the average daily turbidities for the year 1912 are given.

TABLE XCII.

Daily Turbidity of the Allegheny River Water at Aspinwall Determined from Averages of two hourly readings by the City Water Bureau, 1912.

Day.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.	80	16	68	113	149	16	59	9	86	33	41	18
2.	75	16	34	160	75	14	67	11	913	32	33	19
3.	60	16	23	283	49	14	20	12	1,588	35	28	18
4.	47	13	17	143	34	12	11	13	1,013	21	21	23
5.	40	7	29	88	23	13	24	12	231	22	26	67
6.	24	12	20	56	20	15	33	9	112	24	27	141
7.	20	15	29	57	25	14	31	11	88	19	32	178
8.	16	12	19	66	26	13	25	16	73	16	38	130
9.	9	13	27	64	28	22	23	16	54	13	40	74
10.	7	16	44	57	56	17	35	15	45	19	52	73
11.	11	21	28	47	28	14	34	16	33	20	51	58
12.	11	12	44	43	36	17	42	18	27	21	44	56
13.	8	10	100	46	33	15	34	13	20	21	32	42
14.	10	13	85	36	53	18	40	12	50	23	36	42
15.	11	12	55	32	50	15	38	12	33	28	33	17
16.	12	12	1,528	39	50	20	41	12	17	27	26	14
17.	9	10	773	81	211	124	47	13	14	26	26	14
18.	15	12	201	65	188	745	42	18	11	22	19	15
19.	55	11	205	95	79	139	86	14	15	22	25	25
20.	35	33	214	57	45	53	739	162	26	21	24	23
21.	27	94	1,533	37	34	33	585	62	17	18	15	17
22.	22	566	1,056	28	29	29	29	53	22	19	24	13
23.	23	108	196	34	27	24	418	42	28	34	22	13
24.	32	40	107	31	26	18	54	35	28	66	19	13
25.	28	42	137	31	19	16	422	35	21	162	17	15
26.	18	285	94	27	15	58	129	37	42	337	21	18
27.	15	1,917	63	27	14	189	56	587	50	178	29	15
28.	16	783	89	27	15	56	22	298	60	80	20	16
29.	20	148	248	45	21	36	16	127	48	59	24	14
30.	26	.....	158	209	23	17	12	58	40	42	20	23
31.	20	.....	138	.....	18	.....	12	66	.....	36	.....	185
Averages.	26	136	264	70	47	74	175	59	160	48	29	43

The turbidities in the January column of the above table were determined by the silica standard.

Usually with low turbidity the river water carries suspended solids in fine particles. A high river, which means high velocity of current, picks up and carries along heavier matters so that then the suspended solids are coarser. In the following table the suspended solids in the Allegheny River at Aspinwall are expressed in parts in a million and at the foot of the tabular statement is given the range in co-efficient of fineness and the date of the coarsest suspended solids for each month.

TABLE XCIII.

Suspended Solids in the Allegheny River Water at Aspinwall for 1912.
Parts per Million.

Day.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.	56	8	37	74	143	8	31	1	50	92	16	18
2.	52	21	21	87	52	2	31	1	52	38	17	12
3.	35	5	15	385	49	6	1	2	1,431	38	16	16
4.	25	3	7	146	29	2	1	4	481	18	14	13
5.	18	3	11	72	12	5	5	3	216	14	15	53
6.	15	3	7	43	11	10	11	2	107	15	17	17
7.	11	11	11	99	8	7	9	3	61	11	18	100
8.	9	10	6	51	14	11	18	10	65	13	30	92
9.	7	4	21	55	17	10	15	9	39	13	28	68
10.	10	2	31	42	13	8	6	10	28	10	41	43
11.	11	5	9	36	14	9	18	18	25	24	26	32
12.	12	0	3	35	7	5	18	10	19	24	42	32
13.	13	2	4	63	29	17	21	7	18	19	25	26
14.	14	1	4	43	31	22	25	1	8	16	32	19
15.	15	3	452	24	32	15	27	1	16	22	30	19
16.	16	0	889	89	31	18	26	8	26	26	18	12
17.	17	3	328	61	77	625	26	9	9	29	13	8
18.	18	2	176	40	148	231	26	8	17	12	12	18
19.	19	33	272	106	37	58	261	14	12	12	14	13
20.	20	6	237	38	32	32	279	102	13	15	14	15
21.	21	23	698	15	18	22	133	18	19	17	31	15
22.	22	8	142	568	21	17	1,311	13	13	13	24	26
23.	23	16	133	20	14	7	256	12	13	32	16	17
24.	24	18	88	21	12	10	143	29	14	17	20	17
25.	25	18	106	14	13	68	288	25	24	18	14	20
26.	26	117	11	11	19	83	83	25	26	48	16	16
27.	27	4	3,800	58	11	83	28	574	24	113	22	18
28.	28	6	1,200	68	8	27	14	176	67	46	20	14
29.	29	8	189	8	8	20	14	87	39	45	22	13
30.	30	13	127	21	12	14	14	63	23	20	16	8
31.	31	9	117	.....	13	.....	8	40	.....	21	.....	42

Range of Coefficients of Fineness of Suspended Solids.

Date of the coarsest suspended solids.	24th.	5th.	19th.	3d.	17th.	14th.	15th.	11th.	16th.	26th.	26th.	22d.
Minimum.	0.10	0.15	0.38	0.29	0.24	0.13	0.06	0.08	0.36	0.42	0.44	0.42
Maximum.	0.88	1.33	1.30	1.54	1.03	1.10	0.77	1.38	1.73	1.56	1.07	2.00

The character of the Allegheny River water as shown by the turbidity standard has for convenience been divided into three classes. The first class is highly turbid—greater than 120 parts in a million; the second class is a moderately turbid water of from 25 to 120 parts in a million; and the third class is a slightly turbid water of less than 25 parts in a million. The water varies frequently in its apparent color, dependent upon the character and amount of suspended solids. When the water is more or less polluted the colors are various shades of brown, yellowish brown or gray. When the water is clear it has a greenish tinge which may be due to acid or alkali.

Just below Aspinwall is the dam in the river, already described, which back floods water to the dam at Springdale. The latter forms a pool extending up stream to the mouth of the Kiskiminetas River. The extensive coal mining operations in the basin of the Kiskiminetas, detailed above, determine the quality of the waters of this stream. The mine wastes introduce the various sulphur compounds, which when coming in contact with the alkaline waters of the Allegheny River promote coagulation and sedimentation. These changes occur all along the river below the Kiskiminetas and they give a mottled appearance to the Allegheny. Even when the water is quite clear (green) there may be seen floating in this clear or moderately turbid water masses approaching the color of iron rust, sometimes several feet in diameter, or perhaps appearing in streaks. Four or five classes of water may be moving together and the shifting of these causes the sudden changes in the character of the raw water at the Ross Station.

Special studies of these phenomena by experts were made in following out the decree of the Commissioner of Health that experiments should be undertaken to determine how best to pretreat the raw river water. These studies occupied a considerable period of time and were carried out by sanitary engineers employed by the city of Pittsburgh. Reports were made at intervals as the work went on.

Regarding the color and the iron content of the water of the Allegheny River the city's experts have the following to say:—

"The true color of the Allegheny water is seldom sufficiently high to cause comment. It would seem unwise to install any apparatus or process with sole purpose of further decreasing the color which is usually present. The fact is that a comparison of the monthly totals shows that the sand filters do actually cause a certain decrease, unaided by chemical application. However, a drinking water with true color as low as shown in the table leaves little basis for criticism in that direction. Probably the true color of the river water will not increase in future years. Originally there was a considerable amount of timber on the slopes. This is being rapidly cut away and new growths are not being encouraged. The watershed is not used to any considerable extent for farming, and there is little or no swampy, peety land. It is hardly to be expected, therefore, that the true color of the river water will materially increase in the future.

"Except during periods of high water, the total iron content of the river water is seldom in excess of two parts per million. Dissolved iron is practically entirely absent from the river water. Periods of high iron content have never been periods of anxiety in the operations at Aspinwall. The iron at such time seemed to aid in the settlement of the mud which invariably accompanied it. Periods of lower iron content, however, frequently caused very rapid clogging and short runs between cleanings. At such times, the iron undoubtedly reaches the filters in a state of colloidal suspension. Contact with the sand surface cause a true suspension, forming a thin, dense coating which is almost impermeable under the working head of a slow sand filter. The settlement in the sedimentation basins removed about one-half of the total iron, and the filters removed practically all that was left. The ability of the filters to remove the iron is much more marked during the warm weather than during the cold. This is brought about by the fact that the sand surface is in condition to retain the finer particles during the summer. The iron content of the filtered water is never of sufficient magnitude to excite criticism."

In Table XCIV is given a summary of tests of highly turbid Allegheny River water showing the duration in days of this high turbidity, and the turbidity, iron, and alkalinity in parts in a million when the water was yellowish brown in apparent color and light grayish in apparent color. The observations extended over a period of about twelve months.

TABLE XCIV.

HIGHLY TURBID ALLEGHENY RIVER WATER.

Results of Turbidity, Iron, and Alkalinity Determinations of Such Water at City Laboratory, Compiled for the State Department of Health.

Date of Sample.	Duration of high turbidity. Days.	Parts in a Million.		
		Turbidity.	Iron.	Alkalinity.
Yellowish Brown in Apparent Color.				
1910.				
December 30,	2	335	30.5	13
1911.				
January 14,	3	170	7.3	10
January 28,	4	137	6.4	12
April 7,	1	140	7.0	12
September 15,	3	742	32.0	6
September 30,	1	150	4.0	9
Light Grayish in Apparent Color.				
1911.				
August 30,	4	218	14.1	11
September 7,	4	251	10.9	11

The medium turbid water lasts for longer periods than a highly turbid water. In Table XCV is given a summary of determinations of medium turbid Allegheny River water showing the duration in days of this medium turbidity, and the range in turbidity, iron and alkalinity in parts in a million when the water was yellowish brown, grayish, and dark brown in apparent color.

TABLE XCV.

MEDIUM TURBID ALLEGHENY RIVER WATER.

Results of Turbidity, Iron, and Alkalinity Determinations of Such Water at City Laboratory, Compiled for the State Department of Health.

Date of Sample.	Duration of medium turbidity. Days.	Parts in a Million.		
		Turbidity.	Iron.	Alkalinity.
Yellowish Brown in Apparent Color.				
1910.				
October 1,	11	23 to 38	1.7 to 2.0	12 to 26
November 4,	26	33 to 64	1.7 to 2.4	20 to 25
December 23,	7	32	1.6	26
1911.				
January 1,	22	35 to 92	2.1 to 6.1	11 to 16
February 1,	30	42 to 52	2.0 to 2.3	12 to 13
March 12,	26	49	2.0	14
April 8,	26	51	1.8	13
May 10,	4	61	1.4	19
June 11,	12	34 to 71	1.3 to 1.6	16 to 23
July 10,	3	48	1.7	23
August 4,	7	59	1.9	28
September 18,	7	40 to 55	1.3 to 2.5	11
Grayish in Apparent Color.				
1911.				
May 4,	4	40	1.6	18
June 4,	5	51	1.0	14
August 28,	2	94	2.3	21
September 3,	8	53	2.1	13
Dark Brown in Apparent Color.				
1911.				
June 30,	2	23	1.1	19
August 13,	15	23 to 35	1.5 to 2.1	27 to 34

When the Allegheny River water is slightly turbid at Aspinwall it is greenish in color and when this greenish tinge is very light in apparent color, the water will be found to be acid or nearly so. During the series of tests made by experts in the employ of Pittsburgh

to determine the best manner of pretreating the raw river water in carrying out the decree of the Commissioner of Health, special studies were made of the slightly turbid waters. In Table XCVI which follows, the results of turbidity, iron, and alkalinity determinations of slightly turbid Allegheny River waters made by these experts are given.

TABLE XCVI.
SLIGHTLY TURBID ALLEGHENY RIVER WATER.

Results of Turbidity, Iron, and Alkalinity Determinations of Such Water at City Laboratory, Compiled for the State Department of Health.

Date of Sample.	Duration of slight turbidity. Days.	Parts in a Million.		
		Turbidity.	Iron.	Alkalinity.
Greenish in Apparent Color, and Alkaline.				
1910.				
October,	23	14 to 21	1.2	9 to 32
November,	8	18	1.3	22
December,	15	16	1.4	24
1911.				
January,	2	21	1.7	14
February,	3	11	1.1	16
March,	6	15	1.2	14
May,	23	20	1.0	18 to 23
June,	7	16	0.9 to 1.4	12 to 26
July,	28	11 to 16	0.9	12 to 24
August,	12	22	1.3	22
September,	5	15 to 22	0.9 to 1.1	9 to 12
Light Greenish in Apparent Color, and Acid or Nearly So.				
1911.				
June,	2	10 to 15	0.3	0
July,	3	5	0.3	+3 to -4

Before the dams were built at Aspinwall and Springdale, the average turbidity was fifty, the alkalinity thirty-four and the iron 0.75. In the following Table XCVII, is given a summary of the days when different classes of Allegheny River water appeared at Aspinwall, and the average turbidity, iron, and alkalinity of these classes of waters for twelve months, October, 1910, to September, 1911, inclusive. The Aspinwall dam was completed so that the samples represent water collected from the pool in the river made by the dam. It will be observed from the table, that the average turbidity of the river water for these 365 days was fifty, the iron 2.4, and the alkalinity was eighteen parts in a million. There were four days when the river was acid, and less than twenty-five days when the turbidity

was over fifty. So it appears that comparing the waters of the river before the dams were built and after the dams were built, the suspended matters remain the same; but there has been an increase of over two hundred per cent. in iron and a decrease of about fifty per cent. in alkalinity, due to the large amount of acid iron waste discharged into the Allegheny River by the Kiskiminetas.

TABLE XCVII.

Summary of Days When Different Classes of Allegheny River Water Appeared at Aspinwall, and the Average Turbidity, Iron, and Alkalinity of these Classes of Waters for Twelve Months—October, 1910 to September 1911, inclusive.

Class of Water by Appearance.	Number of days appearing.	Average turbidity.	Average total iron.	Average alkalinity.
Highly Turbid:				
Yellowish Brown,	14	303	15.4	19
Light Brown,	8	234	12.5	11
Medium Turbid:				
Yellowish Brown,	181	47	2.1	16
Light Grayish,	19	50	1.7	15
Dark Brown,	17	26	1.8	30
Slightly Turbid:				
Greenish Alkaline,	123	17	1.1	22
Greenish Acid,	4	9	0.3	—1
Mean for 365 days,		59	2.4	18

Mottled water, which is medium or slightly turbid, occurred in the Allegheny River at Aspinwall on twenty-nine days during the year of observation from October, 1910, to September, 1911, inclusive. In Table XCVIII the days on which this mottled water occurred, and the turbidity, iron, and alkalinity are given:

TABLE XCVIII.

Mottled Allegheny River Water at Aspinwall.

Date 1911.	Duration of water. Days.	Parts in a Million.		
		Turbidity.	Iron.	Alkalinity.
March 6,	1	17	2.9	15
March 9,	5	125	1.7	15
April 15,	7	34	1.6	13
April 23,	11	35	1.4	17
September 9,	5	40	1.6	11

Mineral analyses of the Allegheny River water at Aspinwall during the year 1910 were made at intervals when there were unusual conditions. During January the highest turbidity of the year occurred. In February when the river was frozen the water was remarkably clear. The first of March there was a freshet; a few days later the turbidity was about 100; the last of March the turbidity fluctuated remarkably in an interval of two hours; in April the river water contained ferrous iron; in the middle of May the water was light green followed by a black water; in July the water was very green; in August the river was normal; and in September the minimum alkalinity was recorded. A sample of each one of these eleven different kinds of waters was collected and chemically analyzed. The results are given in Table XCIX.

TABLE XCIX.

Mineral Analyses of the Allegheny River Water at Aspinwall for Intervals Durin; the Year 1910, When There Were Unusual Conditions Obtaining as Explained in the Following Notes.

Jan. 31—River elevation above normal: considerable ice floating, following turbidity of 1,400 on January 19th, maximum for year.

Feb. 14—River frozen. In basin water clear and green. Bottom seen.

Mar. 1.—Sample taken just after crest of second highest turbidity of year—660.

Mar. 8—Turbidity for 3 days about 100.

Mar. 30—Turbidity 30 to 115 and back to 30 within 2 hours—sample taken after crest.

Apr. 20—River water very green; ferrous iron in it.

May 14—River water very light green.

May 16—River water very dark colored, almost black.

July 2—Water green both in river and sedimentation basins.

Aug. 13—River normal, no evidence of green water.

Sept. 7—River green. Minimum alkalinity—2.0.

	Jan.		Feb.		March.			April.		May.		July.		Aug.		Sept.	
	31st.		14th.		1st.	8th.	30th.	20th.		14th.	16th.	2d.		13th.		7th.	
Total,	89.0		118.8		551.7	131.6	91.0	154.7		108.3	86.0	162.8		217.0		235.2	
Solids,			15.1		551.7	131.6	91.0	154.7		108.3	86.0	162.8		217.0		235.2	
Loss on ignition,			103.7		491.1	112.0	71.2	133.5		91.3	37.4	183.5		28.1		25.8	
Fixed Solids,	11.2		5.2		388.1	63.4	18.3	4.2		2.5	68.6	144.5		188.9		179.4	
SiO ₂ ,																	
Insoluble other than SiO ₂ ,																	
Fe ₂ ,	3.2*		1.9*		58.5*	12.4*	2.0	0.7		6.4	1.5	5.4		3.2		6.3	
Al ₂ O ₃ ,										1.1	0.8	0.4		1.4		0.3	
Ca,			16.8		11.1	8.3	2.9	0.8		0.6	0.8	0.4		2.0		1.6	
Mg,			2.8		Trace	1.2	9.9	21.9		15.9	13.9	22.4		30.3		28.9	
NaCl & KCl,								6.7		8.7	4.6	7.0		7.9		8.4	
Free CO ₂ ,								15.4		7.0	4.2	10.3					
NO ₃ ,								0.0		2.6	0.9	9.8		3.9		1.3	
Cl,								0.04		0.10	0.12	0.06		0.12		0.08	
SO ₄ ,	1.3		6.0		8.0		8.5	8.5		5.5	8.0	17.5		68.5		99.8	
Alkalinity,	23.0		48.0		16.0	16.0	16.0	71.6		45.5	29.0	79.5		34.0		3.0	
	15.0		14.0		14.0	8.0	16.0	5.0		6.0	20.0	4.0					

* = Fe₂O₃ + Al₂O₃.

The Allegheny River water at Aspinwall is tending towards an acid condition. The alkalinity is decreasing owing to the method of disposal of coal mine wastes on the Allegheny Basin. It was apparent to the State Department of Health in 1908, when the Commissioner of Health issued the decree previously quoted, that the time was not far distant when the city would be forced to apply chemicals to the waters of the Allegheny River to neutralize the acidity in connection with the filtration of the public water supply and to assist in preliminarily clarifying the water. In Table C the monthly average total hardness, and alkalinity of the Allegheny River water at Aspinwall are given to show this tendency towards an acid condition.

TABLE C.

Monthly Average Total Hardness and Alkalinity of the Allegheny River Water
at Aspinwall since 1908.
Parts per Million.

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Total Hardness.												
1908.	132	138	143	114
1909.	45	35	33	33	48	61	82	94	110	79	63
1910.	46	26	33	39	45	70	88	69	72	44	49
1911.	35	38	38	47	62	70	84	58	82	34	32
1912.	41	33	38	33	63	70	66	55	54	43	45
Alkalinity.												
1908.	53	58	50	85
1909.	19	15	17	19	25	28	25	26	24	35	81
1910.	20	14	17	18	19	21	29	19	26	33	32
1911.	12	13	12	13	18	18	27	10	13	18	15
1912.	18	24	14	18	17	11	7	13	18	18	19

A low stage of the river is accompanied by increased alkalinity and total hardness owing to lack of dilution, or would be accompanied by such increase in alkalinity were it not for the mine drainage. It is true, however, that a high river stage is accompanied by low alkalinities and by low total hardness.

In Diagram F it is shown how the hardness of the Allegheny River water at Aspinwall would be reduced if storage reservoirs were built on the Allegheny basin to maintain a minimum flow about four times the present minimum flow of the river.

During most of the year 1912, daily samples of the Allegheny River water were combined to form weekly composite samples which were then analyzed to determine the mineral constituents. The results of these analyses for the months of February, March and April are given in Table CI, and for the later months in two subsequent tables.

The month of January was severely cold and this period extended to February 14th. The precipitation of February was far below the normal, and the river stage was low at Aspinwall from February 1st to February 20th. During March the precipitation was considerably above the normal. On March 22nd, it reached the highest stage of the year. From March 15 to April 11, the river was at high stage. During April, the precipitation was above the normal.

DIAGRAM F **HARDNESS OF ALLEGHENY RIVER WATER AT ASPINWALL** **1909**

DATA FROM FLOOD COMMISSION REPORT

If 13 reservoir projects in Allegheny basin were constructed, and half-full at the beginning of a summer similar to 1909, there could be maintained constantly 4000 second-feet flow equal to 4 times minimum for the 137 days between July and Dec. 1909, equivalent to reduction of 26 parts per million in hardness for the 137 days

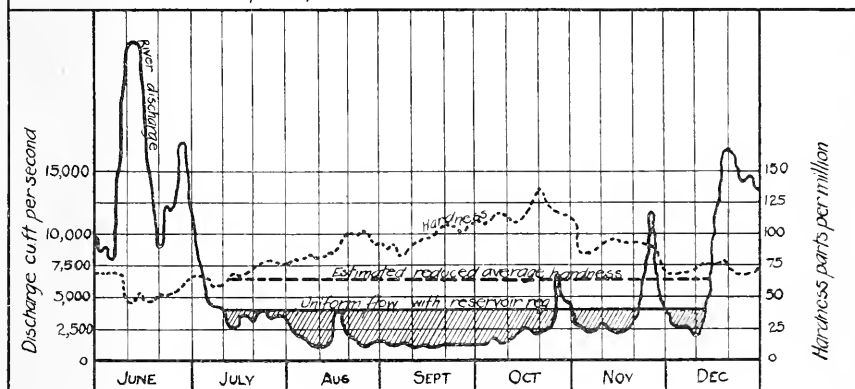


TABLE CI.

Mineral Analyses of Allegheny River Water at Aspinwall for February, March and April, 1912. Aspinwall Laboratory. Weekly Composite Samples.

Parts per Million.

Determinations.	February.				March.				April.				
	1st to 7th.	8th to 14th.	15th to 21st.	22d to 28th.	29th to Mar. 6th.	7th to 13th.	14th to 20th.	21st to 27th.	28th to Apr. 3d.	4th to 10th.	11th to 17th.	18th to 24th.	25th to May 1st.
Total Solids,	127	131	161	356	111	128	462	349	290	132	106	101	135
Loss on ignition,	22	14	31	41	18	17	42	27	29	24	15	15	17
Fixed solids,	105	117	140	315	93	111	420	313	171	108	91	86	118
SiO ₂ ,	6.5	5.5	12.1	144.3	16.5	14.1	270.8	169.5	80.8	48.0	23.2	20.0	29.6
Insoluble matter,	1.3	1.0	1.6	42.4	4.9	3.0	57.2	41.0	20.3	13.0	6.7	5.8	10.1
Fe,	1.1	1.0	1.3	14.4	1.9	3.1	22.4	15.2	5.6	2.7	1.8	2.5	2.7
Al,	0.7	0.7	1.2	9.8	2.3	1.9	14.4	10.0	8.6	4.2	1.8	3.9	1.6
Mg,	15.7	18.3	21.7	14.2	11.9	14.3	10.7	9.1	9.0	6.7	10.4	13.9	12.9
Na, and K,	3.4	4.2	5.0	5.3	3.5	5.3	4.2	3.3	2.8	2.6	2.5	4.1	2.9
Free CO ₂ ,	14.7	17.2	18.3	14.2	10.8	14.2	11.9	7.9	7.4	6.8	6.5	7.9	10.4
NO ₃ ,	2.2	3.0	3.1	5.7	3.1	5.7	5.7	6.6	4.4	4.0	4.0	3.5	4.4
Cl,	1.2	1.3	1.2	1.3	1.2	1.3	1.1	0.7	1.1	0.8	0.6	0.8	0.8
SO ₄ ,	17	26.2	23	14	21.8	14	22.4	6	7	6	8	9	12
Mn.,	36.7	36.2	46.9	20.2	17.4	29.2	29.4	17.4	17.1	14.0	18.1	20.2	24.5
Alk.,	0.32	0.15	0.30	0.30	0.20	0.30	0.62	0.27	0.36	0.20	0.10	0.20	0.70
Soap hardness,	23	29	31	13	17	13	9	9	11	13	15	18	19
	44	54	49	44	33	44	35	31	31	29	25	36	36

In the following tabular statement data are given relative to the river stage in the pool at Aspinwall. The pool level is 24.5. It will be observed that the river water stage was low all through February until the 20th. March was a wet month and the high stage continued throughout April.

1912.	1st.	5th.	10th.	15th.	20th.	22d.	25th.	27th.	30th.
February,	26.4	26.2	26.0	25.8	26.2	27.8	27.0	33.8	*28.6
March,	28.6	27.0	27.1	28.6	31.5	36.5	31.5	.....	33.0
April,	32.0	32.0	30.5	28.6	28.2	.....	27.5	.....	29.0

*February 29th.

TABLE CII.

Mineral Analyses of Allegheny River Water at Aspinwall for May, June and July, 1912. Aspinwall Laboratory. Weekly Composite Samples.

Parts per Million.

Determinations.	May.					June.					July.			
	2d to 8th.	9th to 15th.	16th to 22d.	23d to 29th.	30th to June 5th.	6th to 12th.	13th to 19th.	20th to 26th.	27th to July 3d.	4th to 10th.	11th to 17th.	18th to 24th.	25th to 31st.	
	109	113	145	103	134	139	244	150	191	208	233	465	179	
Total Solids,	27	17	39	20	20	20	36	28	27	34	35	59	33	
Loss of Ignition,	82	96	115	83	114	119	208	123	164	174	198	415	145	
Soluble solids,	16.1	10.7	30.7	3.9	3.7	4.3	58.5	8.7	14.9	5.8	11.1	180	31.1	
Fixed solids,	5.4	2.6	9.2	1.2	1.3	2.1	19.7	2.2	4.0	3.0	4.3	73.4	10.7	
Insoluble matter,	1.4	1.1	3.7	1.0	0.6	0.8	6.4	1.1	1.5	0.7	1.7	24.0	2.3	
Fe,	1.9	1.7	4.2	1.2	1.2	1.2	5.3	1.5	3.2	1.3	2.2	9.2	5.0	
Al,	10.6	13.0	11.4	12.6	18.4	21.0	82.0	19.4	24.7	26.9	28.9	16.0	15.0	
Ca,	2.9	3.7	3.0	2.4	4.6	5.3	5.6	5.1	6.5	6.6	6.5	5.7	5.3	
Mg,	8.3	8.8	7.9	9.6	11.0	12.4	12.7	11.4	13.0	16.3	16.3	9.9	1.1	
Na and K,	3.5	3.1	3.5	2.5	3.1	3.1	6.2	3.1	3.1	2.6	3.0	2.2	4.4	
Free CO ₂ ,	6.7	0.3	0.3	0.3	0.2	0.2	0.4	0.9	0.4	0.7	0.2	1.0	0.6	
NO ₃ ,	8	10	10	10	14	15	15	14	18	21	15	11	12	
Cl,	17.5	26.8	20.6	26.1	21.7	21.3	50.5	53.3	69.1	80.4	79.9	45.8	49.0	
SO ₄ ,	6.02	0.17	0.17	0.15	0.27	0.35	0.42	0.42	0.50	0.62	0.55	0.50	0.45	
Mn.,	17	18	19	19	22	23	8	17	13	13	20	5	8	
Alk.,	26	44	38	40	56	60	60	60	73	80	86	57	50	
Soap hardness,														

The precipitation in May was far below normal and also in June, with the exception of the 16th, when there was a rainfall of 3.19 inches in 24 hours, followed by a sudden rise in the river which dropped off quickly. From May 29th to June 16th, there was a long period of low water in the river at Aspinwall and from June 21st to July 18th. The remaining days in July were wet. During this period the precipitation was 6.61 inches which nearly approached the maximum record for the entire month. The pool level at Aspinwall was 24.5. In the following tabulation are given data concerning the river stages here for May, June and July.

1912.	1st.	5th.	10th.	15th.	17th.	19th.	20th.	25th.	30th.
May,	30.0	28.0	27.5	25.5	.....	.....	28.2	26.7	26.0
June,	26.2	26.2	25.6	25.6	29.4	.....	26.2	25.6	25.6
July,	25.5	25.4	25.4	25.7	.....	28.6	27.2	28.8	26.3

TABLE CIII.

Mineral Analyses of Allegheny River Water at Aspinwall for August, September and October, 1912. Aspinwall Laboratory. Composite Samples.

Parts per Million.

Determinations.	August.				September.				October.				
	1st to 7th.	8th to 14th.	15th to 21st.	22d to 28th.	29th to Sept. 4th.	5th to 11th.	12th to 18th.	19th to 26th.	27th to Oct. 2d.	3d to 9th.	10th to 16th.	17th to 23d.	24th to 30th.
Total Solids,	150	178	194	221	567	158	140	150	188	128	162	160	283
Loss of ignition,	35	22	22	27	53	31	15	16	26	18	33	33	41
Fixed solids,	182	166	172	194	514	137	125	131	112	110	129	127	232
SiO ₂ ,	3.5	3.7	3.9	50.5	100.6	39.2	12.7	10.2	13.6	10.4	9.2	17.9	10.3
Al ₂ O ₃ ,	0.9	0.9	1.7	17.7	100.7	13.2	3.7	2.7	2.6	2.3	2.3	2.4	14.9
Insoluble matter,	0.5	0.6	1.2	4.2	28.8	4.4	6.8	1.0	2.1	1.7	1.8	1.4	9.2
Fe,	1.3	1.1	1.9	4.8	3.8	3.1	1.0	0.9	2.2	1.4	1.2	1.6	3.1
Ca,	17.3	21.3	24.2	17.3	14.0	13.3	19.6	21.9	16.6	24.2	26.9	21.4	15.7
Mg,	5.1	6.8	6.2	4.8	5.4	3.6	3.2	4.9	3.6	4.3	5.2	4.6	4.8
Mg. and K.,	11.2	16.1	19.8	7.1	13.3	12.5	18.3	17.9	18.0	17.2	13.0	13.2	21.9
Free CO ₂ ,	4.4	2.6	3.1	4.4	3.5	2.2	2.6	3.1	3.1	2.6	3.1	3.5	4.8
NO ₃ ,	0.4	0.2	0.5	0.4	0.6	0.5	1.0	0.9	1.6	0.4	0.5	0.3	0.4
Cl,	14	20	20	15	12	9	12	11	11	13	18	18	12
SO ₄ ,	64	75.3	81	48	25.7	28.9	55.1	69.4	39.6	43.5	53.3	51.9	27.2
Mn.,	0.57	0.57	0.35	0.45	0.57	0.35	0.40	0.35	0.15	0.42	0.22	0.22	0.22
Alk.,	2	8	9	14	14	15	14	17	17	18	20	32	29
Soap hardness,	71	76	69	53	42	46	57	57	47	54	57	56	40

During August, the precipitation was below normal. For September and October, it was slightly above normal. From August 1st to August 20th, was the longest period of low water. On the 27th, the river stage at Aspinwall was 29.2 and on the 30th, 27.8. The pool level is 24.5. On September 4th, the stage was 33.7. In the following tabular statement are given data relative to the river stages for these three months:

1912.	1st.	4th.	5th.	10th.	15th.	20th.	25th.	27th.	30th.
August,	26.0	.....	25.8	25.5	26.0	26.6	26.4	29.2	27.6
September,	28.2	33.7	30.0	27.1	26.0	26.2	27.2	.....	26.7
October,	26.6	.....	26.6	25.8	26.0	25.8	29.0	.....	27.9

With respect to the odor of the raw Allegheny River water, the analyst of the Aspinwall filtration plant has the following to say:

"As might well be expected from an inland stream which is practically a large open sewer, the river water always has an appreciable odor. Beside the sewage odor, there is also frequently an oily odor, caused by the presence of crude oil from the oil refineries and oil wells. The reported odors of oil are not a satisfactory index of the quantities of oil and paraffin in the river water. During many days when the oil odor is not found, the river and settling basins give visible evidence of the presence of very considerable quantities of oil, evidently in a somewhat de odorized condition."

In Table CIV the variations in the odor of raw Allegheny River water at Aspinwall for every day in the year 1912 are summarized.

TABLE CIV.

Odor of Raw Allegheny River Waters as noted at the Aspinwall Filtration Plant During the year 1912.

Odor.	Number of Days.											
	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
Musty:												
Very Faint,	2	1	14	3	0	0	11	9	1	0	3	
Faint,	12	8	15	24	12	4	13	12	15	17	11	
Distinct,	7	11	1	2	13	15	4	0	14	11	15	
Decided,	8	9	0	2	5	7	0	0	0	0	2	
Oil,	6	6	0	2	0	4	0	0	4	1	3	
Sweetish,	.....	.....	.....	3	0	0	0	0	0	0	0
Earthy:												
Very Faint,	.....	.....	.....	.....	3	1	0	0	0	0	0
Faint,	.....	.....	.....	.....	1	1	0	1	0	.....	.....
Distinct,	.....	.....	.....	.....	0	0	0	0	1	.....	.....
Vegetable:												
Very Faint,	.....	.....	.....	.....	.....	1	0	5	0	.....	.....
Faint,	.....	.....	.....	.....	.....	1	0	6	0	.....	.....

In Table CV, which follows, the organic constituents of the river water are shown. Most of the time the water has a musty odor. During the warmer months the earthy and vegetable odors are noticeable.

With respect to dissolved oxygen, the Aspinwall analyst has the following to say:

"While there are no days on which there is no dissolved oxygen in the river water, yet a careful comparison with results of previous years develops the fact the time is not far distant when there will be no dissolved oxygen in the river water during long periods of the year. During June, July, August and September, the quantity is already quite low. In other words, unless steps are taken to prevent the dumping of crude sewage into the river above Aspinwall, the quality of the water will soon be such as to add to the difficulties of treatment, in order to meet the sanitary requirements for a potable water above suspicion. Settlements on the Allegheny watershed above Aspinwall are developing rapidly, while there is little visible evidence of improvement in sewage treatment in these settlements. While the filtration plant seems to have performed its function fully up to the requirements of the most exacting critics, yet at times there seems to be a great lack of consistency in the prosecution of sanitary requirements along the watershed. While a water purification plant should be required to furnish a satisfactory quality of potable water, yet the ordinary requirements of civilization should protect a water supply from the excessive contamination which the Allegheny now receives."

TABLE CV.

Sanitary Chemical Analyses of the Allegheny River Water at Aspinwall for 1911 and 1912.

(Parts per million. Water Bureau Laboratory.)

Month.	True color.	Dissolved oxygen.	Nitrogen as				Oxygen consumed.
			Ammonia.		Nitrites.	Nitrates.	
			Free.	Alb.			
1911.							
January,	4	.....	.027	.189	.006	.28	4.1
February,	3	.....	.041	.102	.005	.21	2.5
March,	2	.....	.034	.092	.004	.21	2.1
April,	0	.....	.024	.126	.005	.21	2.5
May,	0	.....	.046	.117	.006	.10	2.1
June,	0	.....	.085	.133	.004	.06	2.2
July,	1	.....	.219	.110	.003	.03	2.1
August,	7	.....	.165	.247	.005	.05	9.0
September,	12	.....	.020	.143	.005	.10	3.7
October,	6	.....	.050	.230	.006	.12	4.0
November,	3	.....	.051	.117	.007	.14	3.1
December,	5	.....	.038	.114	.007	.25	2.9
1912.							
January,	1	13.2	.099	.240	.011	.27	4.0
February,	4	14.0	.037	.186	.008	.26	4.0
March,	5	11.8	.010	.184	.006	.19	4.2
April,	4	10.2	.032	.103	.005	.09	3.3
May,	4	9.1	.069	.066	.005	.12	2.5
June,	4	8.4	.131	.087	.004	.11	3.3
July,	3	9.7	.077	.143	.003	.08	2.4
August,	4	8.7	.065	.202	.004	.09	4.0
September,	5	9.5	.047	.086	.005	.09	3.4
October,	7	12.1	.026	.068	.006	.07	2.4
November,	5	12.1	.026	.068	.006	.07	2.4
December,	6	13.9	.031	.055	.007	.09	2.8

Summarizing the river water character—the Kiskiminetas is acid from two causes, namely, the decomposition of shale and culm piles near the coal mines, and the drainage from the mines themselves. Such acid waters contain silicates and sulphates of aluminium, manganese, calcium and magnesium, and also free acid. When diluted by the alkaline waters of the creeks, these acids change. The sulphates of iron, aluminium and manganese, decompose, producing hydrates of these metals and also sulphates of calcium, magnesium, etc. Some of these bodies and silicates exist in a semi-soluble condition and do not precipitate even when mixed with the Allegheny River water. The precipitating action which follows can be observed all along, even in the Kiskiminetas and many of its tributaries; as evidenced by the iron coloring on the rocks and the bed of the stream and further by the scouring out of some of these iron deposits in flood time.

The Allegheny river above the Kiskiminetas is different. It is alkaline, often turbid, and never acid; it carries clay, oil and also paraffin. Where the Allegheny and Kiskiminetas meet, there is a marked coagulation and precipitation of the iron and aluminium; but there is no regularity in the action. A sudden rise in the Kiskiminetas River will characterize the waters of the Allegheny and manifest itself in the Ohio River. A rainfall on the upper Allegheny Basin and not on the Kiskiminetas will send down into the Ohio River a water of an entirely different character. And so at Aspinwall, one day the water may be approaching an acid condition and the next day it may be alkaline. Within a few days the water may change from one which contains clay particles that remain suspended indefinitely, to one containing particles that subside after a few hours quiescence. The highest turbidity of 3,900 parts in a million was of short duration. Marked changes are also shown in dissolved constituents. When calm, the surface of the river water shows a coating of oil or paraffin.

(e)—Difficulties Encountered in Operating the Aspinwall Filter Plant, Imposed by the Allegheny River Water.

The original layout of the Aspinwall Filter Plant in 1899, was for twenty-five acres of uncovered slow sand filters, capable of delivering an actual yield of fifty million gallons for twenty-four hours and of yielding a maximum of seventy-five million gallons for twenty-four hours. When the city came to build the plant, forty-six acres of filters were constructed and they were covered over as described; but it has never been possible to obtain this rate of two million gallons an acre, or a daily output of ninety-two million gallons of satisfactory water under adverse conditions in the Allegheny River without application of a germicide. In 1906, before the forty-six filters were ready to be

put in operation, it was estimated that four units would always be out of commission and that forty-two units would be in actual service. Furthermore, it was estimated that with normal Allegheny River water, a unit would deliver an average of 2.525 million gallons each twenty-four hours for twenty days between cleanings, equivalent to a total yield of fifty million gallons; and that for the worst Allegheny River water, a unit would deliver 2.417 million gallons each twenty-four hours for twelve days between cleanings, equivalent to a total yield of twenty-nine million gallons, and that for the best Allegheny River water, a unit would deliver 2.91 million gallons each twenty-four hours for thirty-five days between cleanings, equivalent to a total yield of 102 million gallons daily. Experience has shown that for the normal and best Allegheny River waters, four units out of commission at a time are sufficient; but when the raw waters are at their worst and each filter unit cannot be run over twelve days, it is at times necessary to have at least eight units out of commission.

The average number of units in use each day by months, and the average daily yield in million gallons to the unit by months for the last three years, are given in Table CVI.

TABLE CVI.

Daily Yields of Filters at the Aspinwall Filter Plant for Three Years.

Month.	1909.		1910.		1911.	
	Per Day.	Per Unit.	Per Day.	Per Unit.	Per Day.	Per Unit.
January,	42	1.64	42	2.21	34	2.70
February,	41	1.73	41	2.30	34	2.62
March,	41	1.95	36	2.41	33	2.64
April,	41	1.90	39	2.16	30	2.76
May,	42	1.95	37	2.35	32	2.75
June,	42	2.00	38	2.37	34	2.76
July,	42	2.07	39	2.46	35	2.77
August,	42	1.93	37	2.60	34	2.76
September,	41	2.05	35	2.70	33	2.73
October,	35	2.31	34	2.70	31	2.84
November,	35	2.34	32	2.75	34	2.53
December,	41	2.02	35	2.70	31	2.64

In the closing months of the year 1909, sewage organisms were found in the filtered water in ten cubic centimeters, on an average of eight days in the month. Beginning January of 1910, hypo-chlorite of lime solutions were applied to the filtered water. In the following Table CVII is noted the number of days on which B. Coli have been found in the filtered water at the Aspinwall plant.

TABLE CVII.

B. Coli in Ten Cubic Centimeters of the Aspinwall Filtered Water since the Plant Was Started. The Table Prepared from City Records.

Month.	1909.	1910.	1911.	1912.
	Days B. Coli Found.			
January, .....	.....	1	Absent.	3
February, .....	.....	Absent.	Absent.	5
March, .....	.....	1	Absent.	5
April, .....	.....	3	1	Absent.
May, .....	.....	1	3	1
June, .....	.....	3	3	2
July, .....	.....	4	4	3
August, .....	.....	5	6	1
September, .....	.....	5	9	4
October,	9	6	3	4
November,	8	6	Absent.	2
December,	8	5	5	3
Totals,	25	40	31	33

The filtrate should be free from sewage organisms.

The Aspinwall sand filters clog rapidly and give low yields in consequence. No one thing is the sole cause, but by way of explanation it may be stated that the general cause is the mixing of the waters of the two chemically unlike streams, the Allegheny and the Kiskiminetas Rivers, and the incomplete precipitation of the bodies which result from this mixture. In Table CVIII are given chemical analyses of these river waters before their union and of these waters mixed in various proportions. In the first column appears the determination. In the next column these determinations for a sample of the Allegheny River water collected just above the Kiskiminetas are given; in the next column the same determinations for a sample of the Kiskiminetas River water collected just above the Allegheny River are given; in the fourth column are given the results of the analysis of a mixture of some of the sample of Allegheny River water with some of the sample of Kiskiminetas River water, the ratio being seven to three; similarly for the last two columns, the ratios being two to eight and one to nine, respectively. These tests and those in the table which follows were conducted by the expert employed by the city to carry out the provisions of the Commissioner of Health's decree calling for experiments to determine the best form of pre-treatment of the raw Allegheny River water at Aspinwall.

TABLE CVIII.

Chemical Analyses of Allegheny River Water and Kiskiminetas River Water Before Their Union, and of Mixtures of the Same Samples in Three Different Proportions.

Parts per Million.

Determinations.	Allegheny River.	Kiskiminetas River.	Mixture.		
			7 to 3	2 to 8	1 to 9
Oxygen consumed,	262	10.06	116	40.4	25.5
Nitrogen as					
Free ammonia,	17.1	0.592			
Albuminoid ammonia,	4	.058			
Nitrates,	0	0			
Chlorine,	13.98	7.37	12.01	8.67	8.03
Sulphuric Acid,	25.84	142.5	60.85	119.16	130.85
Alkalinity,	44.3	—26.5	23.06	—12.31	—19.4
Hardness,	61.4	195.0			
Iron (Fe), .....	.37	5.52	2.63	4.69	5.10
Residue on Evaporation:					
Total,	431	252	377	258	270
Suspended,	236				
Dissolved,	295				
Manganese (Mn),	0.57				
Calcium (Ca),	10.50	27.67	15.65	24.23	25.95
Magnesium (Mg),	5.20	8.17	6.09	7.58	7.87
Silica (SiO ₂),	15.55	8.25	13.36	9.71	8.98
Aluminium (Al),	15.60	7.02	13.03	8.74	7.89
Sodium and Potassium,	13.83	21.57			
Loss on Ignition:					
Total,	318				
Suspended,	118				

When these waters are mixed, coagulation occurs immediately, but in varying degrees. With sixty to seventy per cent. Allegheny River water, it occurs quickest. After three hours mixture, forty per cent. Allegheny River water shows the best clarification. The best result is found with twenty-five per cent. Allegheny River water. The acid Kiskiminetas hydrolizes and precipitates iron oxide on standing. In Table CIX are given some results of mixing different proportions of the two river waters, allowing coagulation to occur and then filtering through paper.

TABLE CIX.

Iron and Alkalinity Determinations of Various Mixtures of the Allegheny River Water and the Kiskiminetas River Water after the Mixture has been Coagulated and Filtered Through Paper.

Parts per Million.

Sample.	Ratio.	Iron.		Alkalinity.
		A.	B.	
Allegheny River, unmixed,		1.37	1.37	44.3
Mixture of the two river waters,	9 to 1	1.78	1.78	
Mixture of the two river waters,	7 to 3	1.84	2.02	21.0
Mixture of the two river waters,	6 to 4	2.68	2.03	
Mixture of the two river waters,	5 to 5	2.96	2.25	8.2
Mixture of the two river waters,	4 to 6		2.86	5.8
Mixture of the two river waters,	3 to 7		4.27	1.4
Mixture of the two river waters,	2 to 8	0.56	4.69	—13.9
Mixture of the two river waters,	1 to 9	2.72	5.10	—23.1
Kiskiminetas River, unmixed,		5.52	5.52	—26.5

A means Determined.

B means Computed.

It will be noted that the amount of iron precipitated and retained on the filter paper was greatest in twenty-five per cent. Allegheny River water.

When the two rivers mix, the iron is precipitated more rapidly than the aluminium and the silicon, but some remains in combination with aluminium and manganese in the form of silicate. This iron is the least of all the metals in combination in suspension, and the aluminium is the highest. During the drier months when the Kiskiminetas characterizes the Allegheny water at Aspinwall, occur the greatest summer troubles at the Aspinwall filter plant, due to a peculiar sudden clogging of the sand surface and a marked reduction in the yield of the filter. A pasty substance collects on the filters. Were it granular there would be no difficulty. This substance exists in the water in a partially dehydrated form and is dehydrated further at the surface of the sand, causing the clogging. These finely divided hydrates of iron and aluminium are so fine, that they will not settle out; but in contact with suspended matter, they become grouped into masses large enough to settle and so they are deposited in the bed of the stream. During low turbidity, these hydrates not having a body of clay to work on as matrix, reach the Aspinwall filters and form on the surface of the sand beds a gelatinous mass. Aluminium, more than iron, is present in this form.

The substances which cause the most difficulty are colloidal silicates of iron and aluminium and manganese which not only precipitate in the sand filter as do the hydrates of these metals, but also possess the power to cement the sand grains into a layer. Sometimes this extends as far as four inches into the sand. This condition may be brought about at any time by any agent that will cause precipitation of colloidal silicates. At times of high turbidity of the river water the action occurs naturally in the stream. At other times it occurs on the sand surface of the beds and cuts down the yield of the filters one-third. A low alkalinity, low turbidity, low sulphate and the presence of paraffine, are other agencies and conditions under which any slight change may cause the coagulation of the silicates in the upper layer of the sand beds.

Oil or paraffine is always present in the Allegheny River water at Aspinwall. It collects on the river surface and on the surface of the water in the sedimentation basin, during calm days. Sometimes the film of paraffine is white like ice. It collects on the sand surface and it is a contributory cause of filter clogging. When cold weather sets in, between four and seven degrees centigrade, there is a sudden clogging due partially to paraffine ice formation.

(f)—Experiments on Preliminary Treatment of the Allegheny River Water.

The city of Pittsburgh employed Mr. George A. Johnson, a consulting engineer, expert in the treatment of waters, assisted by Mr. Robert Spurr Weston to make the tests required by the Commissioner of Health to determine the most efficient and economical method of suitably preparing the waters of the Allegheny River for final filtration through the slow sand filters at Aspinwall, to get the maximum daily yield from the fifty-six acres of filters now constructed—possibly 200,000,000 gallons. It was established by these experts, that, beyond all doubt, the speedy clogging of the filters is due primarily to the acid condition of the Allegheny River, and the presence in the river water of unprecipitated colloidal hydrates and silicates of iron, aluminium and manganese, complicated at times by the presence of coloring matter and paraffine-like bodies, and by sudden changes in mineral constituents and the temperature.

The sole object of the treatment sought by the experiments was to coagulate the fine, suspended, gelatinous hydrates and silicates before they reach the sand surface of the filters. It was found that the simple addition of chemicals and clay would not be sufficient, for the available period of subsidence in the existing sedimentation basin is too short. Contact is necessary, even after the addition of suitable coagulants, efficiently and economically to remove the substances that interfere with filtration. It was found by experiment that in passing raw Allegheny River water over baffles, the best forms of which are basins filled with coarse gravel, the interfering matters will be retained in the baffles. Contact alone, without chemicals, will be sufficient for the treatment of this river water for at least 175 days in the year.

The main factors in the contact treatment are depth and size of material. A rate of 75,000,000 gallons an acre a day and a depth of eight feet of gravel, ranging from half an inch to one inch in diameter, is best adapted to local conditions as shown by the experiments. A baffle built of such material will not need more than fifty cleanings in a year. As planned they are to be built of concrete and in compartments, so that any one compartment may be flushed out by opening large gates connecting at the bottom to the sewer.

The experiments proved what the State Department of Health believed they would prove, that no known system of water purification employing single filtration can purify the Allegheny River water at Aspinwall without preliminary treatment embodying for the future the application at times of chemicals.

For water high in turbidity, no chemical is necessary, although the addition of a little sulphate of alumina would be desirable at times. The summary of chemical treatment, and the recommendation of the experts were as follows:

"The addition of clay and sulphate of alumina is indicated for water containing hydrates and silicates of iron, aluminum and manganese. The addition of clay alone will prevent clogging for awhile, but ultimately the application constantly of fine clay will clog the sand and reduce the yield of the filters. It is necessary to add enough sulphate of alumina with the clay to secure good coagulation and thereafter effect the removal of the bulk of the precipitated matter by means of the baffles and basins. In other words, it is necessary to increase the specific gravity of the suspended matter and thereby accelerate its speed of subsidence.

"Treatment with sulphate of alumina alone prevents the cementation of the sand, but enough fine aluminum hydrate is carried to the filters to cause surface clogging. The amount of clay, in conjunction with sulphate of alumina, would vary between twenty and sixty parts per million, equivalent to from about 165 to 500 lbs. per million gallons; the amount of sulphate of alumina would vary between three and twenty parts per million, equivalent to from about 25 to 165 lbs. per million gallons. These amounts are quite small and the average would not exceed forty pounds of clay and ten pounds of sulphate of alumina per million gallons.

"The addition of sulphate of alumina alone is indicated for the treatment of a water containing organic coloring matter and tannery waste. It is possible that clay may be needed in the future, but conditions requiring it have not been met during the past year. Treatment with sulphate of alumina alone, would be required for about sixty days annually, and an average of about ten parts of the chemical per million, equivalent to eighty-three lbs. per million gallons, would have to be used.

"Waters containing colloidal silicates require the same treatment as those containing colloidal hydrates. These two kinds of water occur during about the same periods and usually require treatment together. Both kinds of water together would require treatment for about 120 days annually.

"For water containing fine turbidity, the addition of sulphate of alumina alone would be required. This treatment may be estimated to be necessary for ten days annually. Fine turbidity occurs in the water at other periods, but it is less important at such times because of the presence of other substances requiring chemical treatment.

"Lime must be added when the water is acid and possibly when the alkalinity approaches zero. The addition of sal-soda does not give so good results and caustic soda is too expensive, although efficient. As the acidity of the water may increase in the future, it is difficult to estimate how often or how much lime will be required. Judging from the composition of the river water during the past year, it is estimated that lime, to the extent of ten parts per million, will be required for twenty days per annum. Sulphate of alumina and sometimes clay will be required at these times also, as the absence of turbidity, which is usually a characteristic of acid water, is favorable to the accumulation of gelatinous masses and paraffine like bodies in the filters.

"The experiments have shown that, at certain times, great benefit has been derived by the use of bleaching powder. This tends to coagulate the colloidal silicates. It has an added advantage in that it acts as a germicide in the water, provided enough be added. Ordinarily, less than three parts per million were added, equivalent to less than twenty-five pounds per million gallons. It would be good practice to use bleaching powder in conjunction with sulphate of alumina for the treatment of certain waters, especially those containing silicates, as our experiments have shown that the use of chemical materially increased the yield of the filters during periods of low efficiency.

"Chemical treatment may be summarized in the following table:

"Table Showing Estimated Amounts and Kinds of Chemicals to be Added to the Allegheny River Water to Prepare it for Further Purification.

Substance Added.	Days per annum.	Average P. p. m.	Amount added, lbs. per million gallons.	Cost of chemicals per million gallons.
Sulphate of Alumina,	190	10	\$3	\$0 75
Clay,*	120	40	\$3 2	0 83
Lime,	26	10	\$3	0 21

*Used with sulphate of alumina.

"No separate estimate of the cost of bleaching powder is given because it will effect a saving of some sulphate of alumina. The estimated average total cost of chemical treatment, computed upon the data given in the above table, is \$0.675 per million gallons or \$24,630.00 per annum, exclusive of labor and fixed charges for 100,000,000 gallons daily.

"The chemicals may be best applied to the river water near the inlet of Subsidizing Basin No. 2. It is essential that they be added at different points, and each substance should be fairly well mixed with the water before another is added. All the chemicals may be added dry or mixed with water. The devices for the application of the chemicals should be placed in a house which should also provide the necessary storage room for the chemicals."

If additional sedimentation capacity equivalent to ten days storage of the raw Allegheny River water were provided, even this period of subsidence would not alone prepare the water for final filtration at all times, unless chemicals were used now and then when necessary suitably to prepare the water. The city has concluded that factors of cost absolutely bar out this possible alternative for the method recommended.

(g)—Proposed Improvements at the Aspinwall Filter Plant.

The improvements to the Aspinwall Filter Plant, proposed as a result of the experiments made by order of the Commissioner of Health are as follows:

All of the Allegheny River water taken for the public supply by the city of Pittsburgh at Aspinwall, whether chemically treated or not, is to be passed through contact baffles, these baffles to be built of concrete in tank form and divided into units of about sixty-one feet in length by forty-one feet in width each, and there being twenty-four of them to be built in the end of sedimentation basin No. 3, gives a total area of 1.4 acres for a minimum capacity of 100,000,000 gallons of water daily. The contact material is to be gravel ranging in size from half an inch to one inch and the depth of the contact layer is to be eight feet.

After the water has passed through these baffles, the effluent is to be conducted to the existing sedimentation reservoirs. These reservoirs are to be provided with "A" frame baffles. The water from these reservoirs will be applied to the slow sand filter.

A chemical house with all necessary appliances and appurtenances is to be erected; but not until the contact baffles have been tried out.

Furthermore, an additional pumping station is to be erected at once. Its location is to be along the river front adjacent to the present filtered water basin. The pumps are to deliver filtered water to the North Side. The re-pass to the ten filter units, built since 1908, will be completed this season and these additional units will be ready to operate by the time the preliminary treatment baffles are completed. An additional pump is to be installed at the Ross Station. All of

these additions and extensions are imperative for the furnishing of filtered water to the North Side. A new storage reservoir for filtered water, to hold 150,000,000 gallons is being planned for the North Side. The money for all these things is available.

(h)—Summary of the Survey with Reference to Pittsburgh's Water Supply.

Summarizing the sanitary survey of the Allegheny River Basin with respect to Pittsburgh's water supply, it is significant to note that the Aspinwall slow sand filters have been unable to furnish a filtrate free from sewage organisms. When the rate at which the Allegheny River water after sedimentation is passed through the filters is accelerated, as now proposed, an increase in sewage organisms in the filtrate may be expected unless a germicide is applied to the filtered water. Furthermore, there are a number of things that might happen to the filtration plant any one of which might necessitate the introduction of unfiltered water into the water districts of the city for a short time. The City of Pittsburgh, several years ago, requested the State Department of Health to preserve the purity of the Allegheny River water for the protection of the public health, because the Pittsburgh district must use this river as the source of public water supply. The city requested that the State Department of Health include in its orders of pollution abatements, not only sewage pollutions but industrial waste pollutions also. In compliance with these requests, the Department proceeded to make a comprehensive sanitary survey of the entire watershed and the Commissioner of Health has issued decrees all of which has been described above in detail.

The State Department of Health adheres to the policy that it is essential in the interests of the public health to reduce to a minimum the discharge of untreated sewage into the river and its tributaries above the City of Pittsburgh's water works intake. As indicated by the experiments of the experts, already referred to, tannery refuse, waste from oil refineries and oil wells, and the discharge from distilleries and from coal mine operations, each and all have a deleterious influence on, and seriously hinder the efficient operation of the slow sand filters at Aspinwall. The possibility that a generation or so hence the metropolitan Pittsburgh District will consume water from the Allegheny River in excess of one-half of the total flow of the river during droughts, (as the stream now flows) suggests that it will not be sufficient merely to apply improved methods at the slow sand filtration plant; but that the necessities of the case also demand the bestowal of attention at the sources of contamination of the Allegheny River Basin waters.

The Monongahela River is not a satisfactory source of public water supply even at the present time. The contamination of this river and the Ohio River and many of their tributaries, by sewage and industrial wastes and drainage from coal mining and coking operations, is on the increase. No practicable method of restoring the streams to their normal condition of purity has been suggested whereby the waters can be rendered satisfactory for domestic uses. At no distant future date the various municipalities along the Ohio River in the Pittsburgh District, back of the South Side and up the Monongahela River in the Pittsburgh District, and in the same district east of the city and up Turtle Creek Valley, may be supplied with Allegheny River water as before explained and it is vital to the interests of this vast territory that the State of Pennsylvania proceed along a comprehensive plan of action, such a plan as has been inaugurated by the Commissioner of Health, and estimated to extend over a period of three decades before being entirely consummated, to regulate and control and to reduce to the minimum the contamination of the Allegheny River water above Aspinwall and to bring this water to the people of the Greater Pittsburgh District in as nearly its natural potable condition as shall be found practicable; but in carrying out this campaign, involving as it does a continuous policy, attention must be bestowed not alone on those wastes that hinder the rates of filtration at the Aspinwall plant, but on sewage pollutions also.

The city now purposes to prove out the method of preliminary treatment of the water with baffles and chemicals, by a practical experiment on a large scale. The tests already made of the process warrant this larger expenditure of money and if the larger experiment should reveal the desirability of modifying the plans somewhat, these improvements will be embodied in the further application and extension of the method of pre-treatment to the preliminary treatment works contemplated for sedimentation basin No. 1. The State Department of Health deems it inexpedient to issue wholesale orders of abatements of industrial waste pollutions on the Allegheny River Basin, until after the practical experiment on a large scale with the contact baffles and the chemical treatment of the water at Aspinwall shall have developed the full merits and defects of the system. Most of the hindrances to filtration of the Allegheny River water at Aspinwall are due to the acid waters of the Kiskimincias. The tannery wastes and wastes from chemical, pulp, and paper mills come largely from the Clarion River and above. The paraffine complained of is contributed largely at the individual oil wells on the watershed where the crude oil is produced, rather than at the refineries. It is possible that with these various wastes and pollutions excluded from the waters of the Allegheny Basin or minimized, regulated and controlled, and with additional improved facilities for treatment at the

Aspinwall filter plant, the Allegheny River may be continued as the permanent source of public water supply for the Pittsburgh district.

(i)—Conclusions and the 1912 Decree of the Commissioner of Health.

In conclusion the Commissioner of Health on May 8th, 1912, approved the plans for the proposed preliminary treatment of the Allegheny River water at Aspinwall and for the other extensions and improvements to the water works system and issued a decree as follows:

"In view of the foregoing circumstances, it has been agreed and determined, that the proposed improvements to the water works system are in line with the requirements of the decree of the Commissioner of Health to the City of Pittsburgh, dated August 17th, 1908, and that said improvements will not be prejudicial to public health, and I hereby and herein approve the same and grant a permit therefor, subject to the following conditions and stipulations:

"FIRST The city shall forthwith proceed to install the twenty-four contact baffles as proposed, in conformity with the plans submitted, and operate the same and keep daily records of such operation and submit copies of the same and of the operation of the entire filter plant, for filing in the office of the State Department of Health; these reports are to be made on forms satisfactory to the Commissioner of Health; and if the experiments on this practical scale prove the system of treatment with chemicals to be reasonably satisfactory and efficient, then additional contact baffles shall be provided, in conformity with detailed plans to be submitted to and approved by the Commissioner of Health; and the object to be attained in all these improvements shall be to furnish the entire territory of the City of Pittsburgh at all times with a pure and wholesome and satisfactory quality of filtered water.

"SECOND: Plans of the proposed chemical house and apparatus for the application of the chemical to the waters to be filtered or treated, shall be filed in the office of the State Department of Health, together with plans for the new pumping station and the new storage reservoir, and the filing of these plans with specifications and a full report thereon, shall constitute an approval of the same, unless within thirty days of such filing, the State Department of Health modify or amend the same.

"THIRD: The State Department of Health reserves to itself the right to make such suggestions and recommendations to the city regarding the source of water supply and the treatment of the water, as may be deemed advisable by the Commissioner of Health in the interests of the public health. The Commissioner, with the advice and consent of the Governor and the Attorney General, will continue the State policy of carrying on a campaign for the reduction to the minimum of the sewage pollutions of Pittsburgh's source of water supply; but the Department will postpone until after the practical experiments with the chemical and contact baffle method of treatment is tried out, the matter of regulating the discharge of industrial wastes into the said waters of the Allegheny River and its tributaries.

"FOURTH: No other treatment than the one hereby and herein approved shall be applied at the Aspinwall Filter Plant or anywhere in the water works system of the city, without the plans first having been submitted to and approved by the Commissioner of Health.

"FIFTH: The city shall at the earliest possible moment supply filtered water to all of the South Side District with special reference to the Esplen Territory.

"SAMUEL G. DIXON,
Commissioner of Health "

The foregoing report on the sanitary survey of the Allegheny River Basin will show to those who study it a comprehensive policy which will take many years to carry out. The continuity must not be broken if efficient results are to be secured. The work must progress gradually. The policy of the State is becoming understood and accepted as one that subserves the interests of all concerned. It is better that progress in these matters should be by common consent than by compulsion. If the large water power developments projected in the basin and the storage reservoirs proposed by the Pittsburgh Flood Commission are carried forward within the next twenty years, these changes will exert a far-reaching influence on the quality of Pittsburgh's water supply brought down in the channel of the Allegheny River to the intake at Aspinwall.

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Errata:
P. 53 line 11 from below. For phosphorous read phosphorus.
P. 60 The population of Port Allegany should be—about 2,000.
P. 67 line 1. For Belle Camp read Bells Camp.
P. 97 line 16. For Youngstown read Youngsville.
P. 121. There were 25 cases in Polk in 1906.
P. 152 line 16. Let it read Strattonville.
P. 185 line 14 from below. Let it read Elk Run.

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Report on the sanitary survey of the
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